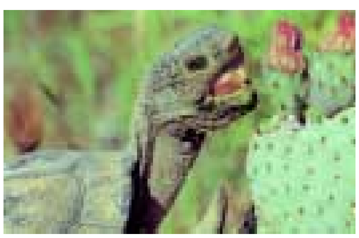
FINAL REPORT

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

FOR THE MOUNTAIN PASS MINE



Prepared for
County of San Bernardino
Land Use Services Department, Planning Division
385 N. Arrowhead Ave., Third Floor
San Bernardino, CA 92415-0182

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EXECUTIVE SUMMARY

The California Environmental Quality Act (CEQA) requires that the environmental impacts of proposed projects be evaluated and that feasible methods be considered to reduce, avoid, or eliminate significant adverse impacts of these projects (ENSR 1996). An Environmental Impact Report (EIR) is being prepared by San Bernardino County to address planned expansions at Molycorp's Mountain Pass Mine facility. This human health and ecological risk assessment (HHERA) for the Mountain Pass mine and mill site is intended to support development of the EIR by evaluating the likelihood of adverse impacts to human health and biological resources that may occur as a result of activities at the mine and mill facility. Risks were evaluated for the Mountain Pass mine and mill facility when the site is operating at full capacity (baseline) and under proposed future expansion conditions.

Based on the analyses of risk, the following conclusions were made:

Human Health Risks

- Risks estimated for baseline and future expansion conditions differ only minimally. Risk estimates for future conditions are slightly higher than those estimated for baseline conditions.
- Cancer health risk estimates were made for three groups: day visitors to the mine and mill site, schoolchildren at Mountain Pass Elementary School (MPES), and residents of Mountain Pass. The risks for all three groups are less than or within the range that is considered by the USEPA to be safe and protective of public health.
- Noncancer health effects to the respiratory system are potential health concerns for Mountain Pass residents.
- Noncancer health risks are negligible for the day visitor and school child.
- Inhalation of lanthanide metals is the primary route of exposure for the

noncancer health concerns determined for Mountain Pass residents.

- Exposures to lead were predicted to be less than the action level recommended by the California Environmental Protection Agency (Cal EPA) and the U.S. Environmental Protection Agency (USEPA).

Ecological Risks

- Ecological risks were evaluated for aquatic and terrestrial biological resources at thirteen areas potentially affected by mine-related activities.
- Most of these areas are located at or near areas that were developed for industrial use, are highly disturbed, and are characterized by human and/or vehicular activity.
- Baseline ecological risks were greatest for plants, aquatic invertebrates, soil invertebrates, and herbivorous and insectivorous mammals.
- Baseline ecological risks to the desert tortoise[1], a federally threatened species, were among the lowest found at the mine and mill site.
- Baseline ecological risks for terrestrial wildlife were greatest at the Seepage Collection Pond, Lanthanide Storage Ponds, Overburden Stockpile, and Windblown Tailings—risks tend to diminish with distance from these areas.
- Baseline ecological risks for aquatic and sediment-associated invertebrates were greatest at onsite ponds in drainages directly below the North Tailings Pond.
- For the most part, exposures at Wheaton Wash/Roseberry Spring (nearby offsite area) pose a negligible risk.
- Risks and the spatial distribution of risks were similar between the baseline and future expansion scenarios.
- Future ecological risks were greatest at the Seepage Collection Pond, Lanthanide Storage Ponds, Overburden Stockpile, proposed East Tailings Pond (assuming windblown tailings), and the future Pit Lake.
- Proposed future Onsite Evaporation Ponds pose a negligible risk to wildlife receptors.

The results of this HHERA indicate that monitoring at the mine and mill site should be expanded to verify predicted risks and to identify and minimize or eliminate future risks.

ES.1 TECHNICAL SUPPORT FOR THE HHERA

Technical review of the HHERA was provided by a group of risk assessment experts. Also, technical support of the HHERA included data review, field sampling conducted at the mine and mill site, and site-specific modeling. These four types of technical support are described below.

Oversight by Technical Work Group

A Technical Work Group (TWG) was established in 1998 to provide oversight and guidance for the preparation of the HHERA. Technical experts on the TWG represented county, state, and federal agencies, including:

- County of San Bernardino
- Bureau of Land Management (BLM)
- National Park Service (NPS)
- California Department of Health Services, Environmental Health Impact Branch (CDHS EHIB)
- California Department of Health Services, Radiological Health Branch (CDHS RHB)
- California Department of Toxic Substances Control (DTSC)
- California Regional Water Quality Control Board, Lahontan Region (RWQCB-Lahontan)

[1] A single desert tortoise has been observed outside the western boundary of the site. Although no desert tortoises have been observed in areas examined in this ERA, risks to the desert tortoise were evaluated to ensure a conservative assessment.

- California Department of Fish and Game (CDF&G)
- U.S. Fish and Wildlife Service (USFWS)

Other representatives included the consultants conducting the EIR for the Molycorp expansion project, Molycorp staff and consultants, and consultants for state and federal regulatory agencies. The TWG representatives were selected for their technical expertise in either risk assessment or a related field. The TWG selected the HHERA contractor, reviewed all methods and input values used to calculate risks, reviewed all interim work products, participated in conference calls and meetings, and provided guidance to the HHERA contractor throughout the risk assessment process.

Data Review Effort

A review of available data was conducted to ascertain whether existing data were sufficient to support the HHERA. Data were compiled from documents characterizing conditions at the mine and mill site. Reported constituent concentrations in soil, sediment, surface water, groundwater, and air were evaluated for completeness and usability. Factors considered were environmental media sampled, sampling location, sampling dates, number of samples, constituents analyzed, laboratory analytical methods, and quality assurance/quality control (QA/QC) data. An assessment of the data quantity and quality was provided to the TWG as well as the identification of key data gaps. Based on this review, the TWG concluded that data for the mine and mill site were insufficient to support the HHERA, with the exception of groundwater data.

Field Sampling Effort

New sampling was conducted to ensure that sufficient data were available to support the HHERA. The sampling and analysis of soil, sediment, surface water, and indoor carpet dust was necessary to quantify exposures of human and ecological receptors. A field sampling work plan was prepared by Tetra Tech (1999). In accordance with the sampling work plan, 160 soil samples, 28 sediment samples, and 24 surface water samples were collected. Over 14,000 separate analyses of the soil, sediment, and water samples were conducted to quantify metals, lanthanide metals, actinide metals, and radionuclides. Indoor air samples were also collected in the school and offsite residences and analyzed for radon. All of the analytical data were validated in accordance with USEPA (1994a, 1994b) guidance. The results of these analyses were provided in the *Field Summary Report* (Tetra Tech 2000a).

In June 1999, the State Department of Health Services (DHS) collected indoor carpet dust samples from the Mountain Pass Elementary School. Samples were analyzed for metals, lanthanide metals, actinide metals, and radionuclides.

The newly acquired data were integrated with data identified from other sources to serve as the dataset for use in characterizing risks in the HHERA.

Modeling

Modeling was conducted to estimate constituent concentrations for environmental media that were not sampled and to estimate future conditions. Three types of modeling were conducted in support of the HHERA:

- Air dispersion modeling was used to estimate baseline and future airborne constituent concentrations (ENVIRON 2000a). Airborne concentrations of metals, lanthanide metals, organics, and radionuclides were predicted for three areas of concern. The predicted concentrations were used to evaluate risks to human receptors.
- Deposition and mixing of airborne particulates with soil was modeled for future expansion activities (ENVIRON June 26, 2000). Metals, lanthanide metals, and radionuclide concentrations were modeled for three areas of concern at the mine and mill site.

- Concentrations of metals, lanthanide metals, and radionuclides in surface water and solids at future onsite evaporation ponds were modeled. The predicted concentrations were used to evaluate risks to wildlife receptors that may be attracted to these ponds as a potential source of drinking water.

All models used in the HHERA were reviewed and approved by the TWG.

ES.2 HUMAN HEALTH RISK ASSESSMENT

The human health risk assessment (HHRA) evaluated the potential for adverse health effects to occur as a result of exposure to chemical and radiological releases under baseline and proposed future expansion conditions for the Mountain Pass mine and mill facility. Based on an evaluation of people who may have relatively high levels of exposure, risks were estimated for three groups of receptors:

- Day visitors: typified as employees of companies transporting materials to and from the mine and mill site.
- Schoolchildren at Mountain Pass Elementary School.
- Offsite residents: Mountain Pass residents (California Highway Patrol and California Department of Transportation employees and families) consisting of three age groups (young children, school-age children, and older children or adults).

Potential human health risks were assessed for exposures to four groups of constituents of potential concern: (1) metals, (2) lanthanide metals, (3) actinide metals, and (4) radionuclides.

Exposures were calculated for all routes through which human receptors may come into contact with the constituents of potential concern. All three groups of receptors were assumed to incidentally ingest soil, have direct skin contact with soil, be exposed to direct radiation from radionuclides in the soil, and inhale airborne constituents. School children and offsite residents were also assumed to incidentally ingest indoor carpet dust, have direct skin contact with indoor carpet dust, and be exposed to direct radiation from indoor carpet dust.

Exposure estimates for inhalation of airborne constituents in the baseline and future expansion scenarios were obtained from air dispersion modeling results. The use of modeling results is standard practice for estimating the concentration of atmospherically dispersed constituents because air-monitoring data are generally not available, and future conditions can only be estimated by modeling.

Human health risks were calculated for cancer and noncancer health effects for baseline and future expansion conditions. Risk estimates for future conditions are slightly higher than those estimated for baseline conditions. Cancer risk estimates for all three groups of receptors were calculated to be less than or within the range that is considered by the USEPA to be safe and protective of public health. Potential noncancer health effects for day visitors and school children were also estimated to be acceptable. Only the estimated noncancer health effects for the offsite residents are of potential concern.

Potential health concerns from lead were evaluated using the Department of Toxic Substances Control's lead spreadsheet model. Using this model, risks from lead exposures were calculated for exposures to this metal in soil, indoor carpet dust, and air. All of the risks predicted for the three groups of receptors were less than the action level recommended by the Cal EPA and the USEPA.

Based on the results of the exposure and risk evaluations, the risks estimated for the day visitor and school child are negligible. Only the noncancer risks are of potential concern for the offsite residents.

The primary noncancer health risk for offsite residents was determined to be respiratory health effects potentially resulting from the inhalation of lanthanide metals. The respiratory system effects of the lanthanide metals involve cell changes in lung tissue (Toxicology Excellence for Risk Assessment [TERA] 2001). None of the other constituents of potential concern were demonstrated to individually be health concerns, although several constituents of potential concern also cause respiratory effects. Respiratory noncancer health risks for offsite residents were demonstrated to be nearly identical for both baseline and future expansion conditions.

The predicted noncancer health risks for offsite residents necessitate further consideration. First, the estimated health risks are based on exposure concentrations estimated using air dispersion modeling. However, recent air monitoring conducted in the vicinity of the mine and mill site indicates that the air modeling results may have overestimated exposures to airborne lanthanide metals. Second, the health effects of lanthanide metals are also based on a relatively small set of experimental studies. As a result, there is a considerable level of uncertainty associated with these risk estimates.

The potential risks to offsite residents should be addressed by adopting a long-term monitoring program. The monitoring program should include measurements of wind speed and direction at the primary receptor locations as well as the concentrations of airborne constituents, such as the lanthanide metals. Also, additional experimental evidence is necessary to fully characterize the potential health effects of the lanthanide metals.

ES.3 ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment (ERA) evaluated the likelihood of adverse ecological effects that may occur as a result of exposure to metals, lanthanide metals, and radionuclides. Adverse effects (risks) examined by this ERA are impacts related to sustaining existing desert communities and resident wildlife populations. Potential ecological risks were evaluated for the following biological resources observed at the mine and mill site:

- Aquatic and sediment-associated invertebrate communities
- Plant communities
- Soil invertebrate communities
- Desert tortoise and other reptile populations
- Waterfowl populations
- Herbivorous, insectivorous, and carnivorous bird populations
- Herbivorous, insectivorous, and carnivorous mammal populations

Fish and amphibians have not been observed at the mine and mill site and were not evaluated due to the lack of suitable habitat.

Ecological risks were evaluated for twelve onsite areas and one nearby offsite area that were potentially affected by mine-related activities, yet were considered by the TWG to be suitable to support biological resources. Most of these areas potentially affected by mine-related activities are located at or near onsite areas that were developed for industrial use, are highly disturbed, and are characterized by human and/or vehicular activity. Based on visual observations, habitats immediately surrounding these areas appeared to be relatively undisturbed by site-related activities and are likely to more attractive to wildlife receptors.

Under the baseline scenario, the greatest potential for adverse impacts exists for:

- Aquatic and sediment-associated invertebrate communities at onsite springs in drainages directly below the North Tailings Pond
- Desert plant communities at the Seepage Collection Pond, Windblown Tailings, and Overburden Stockpile
- Soil invertebrate communities at the Lanthanide Storage Ponds
- Mammal populations at the Lanthanide Storage Pond

A single desert tortoise, a federally threatened species, has been observed outside the western boundary of the site. Although no desert tortoises have been observed in areas examined in this ERA, risks to the desert tortoise were evaluated to ensure a conservative assessment. Risk estimates for the desert tortoise were among the lowest calculated for the mine and mill site—exposures at the Lanthanide Storage Ponds and Overburden Stockpile posed the greatest risk to this species of regulatory concern.

Baseline ecological risks were greatest at the Seepage Collection Pond, Lanthanide Storage Ponds, Overburden Stockpile, and Windblown Tailings. Baseline ecological risks tend to diminish with distance from these areas. For the most part, baseline ecological risks are negligible at Wheaton Wash/Roseberry Spring, a nearby offsite area.

Results from the North Tailings Pond suggest that minimally disturbed areas surrounding developed impoundments pose a negligible risk to plant, invertebrate, and wildlife receptors. Nonetheless, effective "housekeeping" at these developed areas and controls to reduce contact (*e.g.,* fences) are likely to significantly reduce the potential for adverse ecological impacts at the mine and mill site.

Because baseline conditions were often used to estimate future risks, the magnitude and spatial pattern of future risks are similar to the baseline scenario. Based on ERAs for the future expansion scenario, the Seepage Collection Pond, Lanthanide Storage Ponds, Overburden Stockpile, future East Tailings Pond, and future Pit Lake will pose potential risks to desert plant communities, invertebrate communities, and/or wildlife populations, unless future reclamation efforts are performed. The future onsite evaporation ponds are predicted to pose a negligible risk to wildlife populations.

Under the proposed plan, the North Tailings Pond will be closed and reclaimed—a lined East Tailings Pond will be established to handle future tailings processing. Thus, seepage of tailings pond water will be eliminated. The elimination of tailings pond seepage will (a) result in the loss of several attractive onsite springs and (b) significantly reduce metal, lanthanide metal, and radionuclide exposures to aquatic and sediment-associated invertebrate communities in nearby, offsite springs (*e.g.,* Roseberry Spring). However, if seepage is not eliminated, risk analyses suggest that aquatic and sediment-associated invertebrates in downgradient springs may be adversely impacted.

Preliminary analyses for mammals indicate that restricting access to the Lanthanide Storage Ponds and Tailings Pond (both current and future) would significantly reduce wildlife exposure to lanthanide metals at the mine and mill site. Given the lack of lanthanide toxicity data for many biological resources, restricting access may be considered in the EIR as an initial cost-effective means to minimize potential risks.

Judicious monitoring at future expansion areas can provide the information needed to (a) verify predicted risks and (b) proactively identify and minimize or eliminate potential future risks.

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GLOSSARY OF ACRONYMS

This table provides the full text for acronyms used within the Final HHERA Report.

Acronym	Explanation
AOC	Area of concern
ATSDR	Agency for Toxic Substances and Disease Registry
BLM	Bureau of Land Management
Cal EPA	California Environmental Protection Agency
Cal OSHA	California Occupational Health and Safety Administrations
Caltrans	California Department of Transportation
CHP	California Highway Patrol
COPC	Constituent of potential concern
CSM	Conceptual site model
DCF	Dose conversion factor
DTSC	Department of Toxic Substances Control
DHS	Department of Health Services
EIR	Environmental impact report
EPC	Exposure point concentration
ERA	Ecological risk assessment
DF&G	California Department of Fish and Game
HHERA	Human health and ecological risk assessment
HHRA	Human health risk assessment
HI	Hazard index
HQ	Hazard quotient
LD_{50}	Lethal dose for 50% of experimental subjects
LOAEL	Lowest observable effect level
MCL	Maximum contaminant level
MDL	Method detection limit
MF	Modifying Factor
MPES	Mountain Pass Elementary School
MSHA	Mine Safety and Health Administration
NOAEL	No observable adverse effect level
NPS	National Park Service

Acronym	**Explanation**
PQL	Practical quantitation limit
REL	Reference exposure level
RfC	Reference concentration
RfD	Reference dose
RME	Reasonable maximum exposure
RTV	Reference toxicity value
RWQCB	Regional Water Quality Control Board
SF	Slope factor
TERA	Toxicology Excellence for Risk Assessment
TWG	Technical Work Group
UCL_{95}	95% upper confidence limit
UF	Uncertainty factor
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

1.0 INTRODUCTION

Lanthanide metals (also known as lanthanide series metals or rare earth metals) are a group of 15 elements that are used in electronic, automotive, environmental, and medical technologies. Mountain Pass Mine is the only commercial U.S. mining operation producing lanthanide metals. Mountain Pass Mine has supplied raw material for one-third of the world's need for lanthanide metals.

Mountain Pass Mine is located in eastern San Bernardino County, approximately 15 miles from the California-Nevada border and approximately 50 miles southwest of Las Vegas, Nevada (Figure 1-1). The facility has been in operation since 1951. The mine and mill site occupies approximately 2,100 acres of land.

In December 1996, a draft Environmental Impact Report was prepared by San Bernardino County to address Molycorp's proposed mine expansion plan. This 1996 draft Environmental Impact Report provided a detailed description of existing facilities as well as the environmental assessment of proposed expansion alternatives. In response to comments to the 1996 draft Environmental Impact Report and changes to proposed expansion activities, a new draft Environmental Impact Report (EIR) is now under preparation.

The purpose of the Human Health and Ecological Risk Assessment (HHERA) is to evaluate the potential for adverse human health and ecological effects that may occur as a result of proposed expansion of mining operations at Mountain Pass Mine facility. This information will be used to support the development of the EIR.

Although the primary purpose of the HHERA is to support the preparation of the EIR, the information contained in this report goes beyond what is generally required for planning purposes. Because the HHERA work plan (see Appendix I) was developed in partnership with county, state, and federal regulatory agencies, information in the HHERA may be used by agencies to assist in the development of responses to community concerns. However, the HHERA report was not designed nor is it intended to address regulatory compliance issues.

A Technical Work Group (TWG) was convened to provide oversight and guidance to the contractor hired to prepare the HHERA on behalf of San Bernardino County (the County). Technical representatives to serve on the TWG were identified by most of the state and federal agencies that had been participating in the meetings held to evaluate spills released from Molycorp's wastewater pipeline in 1996. The TWG representatives were selected for their technical expertise in either risk assessment or an integrally related field. The County requested that Dr. William Gorham of ENSR lead the TWG since he had been closely involved with the Molycorp expansion project as ENSR's project manager for the County's EIR. The TWG selected the HHERA contractor, oversaw all aspects of the conduct of the HHERA, reviewed all work products, participated in conference calls and meetings, and provided guidance to the HHERA contractor throughout the process. The detailed composition of the TWG changed through the completion of the HHERA although the key agencies have been informed of all decisions and provided opportunities via e-mail, teleconference calls, and hard copies of reports to participate in all discussions and reviews of all deliverables. A list of past and current TWG members and their affiliations is provided in Table 1-1.

1.1 SCOPE OF THE HHERA DOCUMENT

To organize the risk assessment, the HHERA partitions Mountain Pass Mine into three operational units:

- Mountain Pass mine and mill site
- Wastewater pipeline
- New Ivanpah Evaporation Pond.

These operational units are located in three distinct geographic locations and habitats, are likely to have different types of constituent releases to the environment, and are likely to have different sets of human and wildlife receptors. Partitioning Mountain Pass Mine into these operational units organizes and simplifies examination of expansion designs, facilitates examination and communication of risks, and permits a quick response to later revisions of proposed expansion activities.

This risk assessment addresses activities at Mountain Pass mine and mill site operational unit only. Risk assessments of the Wastewater pipeline and New Ivanpah Evaporation Pond will be completed separately at a later date.

1.2 MINE & MILL SITE BACKGROUND

1.2.1 Site History

In 1949, a deposit of lanthanides was discovered in the area now known as Mountain Pass. Molycorp Incorporated (formerly Molybdenum Corporation of America) purchased several mining claims in 1950 and 1951 after the area was mapped by the U.S. Geological Survey. The Mountain Pass Mine has been in operation since 1951 as an open-pit mine of lanthanide elements. Through extensive prospecting and land acquisition, the Mountain Pass ore body became the primary producer of lanthanides in the United States and the largest ore body of its kind in the world. A europium plant was built in 1965, and a tailings facility (the North Tailings Pond) was developed in 1967. In 1981 a separation plant (now known as the Specialty Plant) was constructed. Molycorp became a subsidiary of Union Oil Company of California in 1977.

1.2.2 Mine Operations and Waste Characteristics

All working areas of the mine are located in the mine and mill site operational unit. The major processes that occur at the mine and mill site include:

- Open pit mining
- Crushing and Blending

- Flotation
- Filter-Drying
- Roasting
- Leaching
- Solvent Extraction
- Lanthanum Precipitation
- Waste Water Treatment

Operations at the mine and mill site are illustrated in Figure 1-2. Locations of existing and proposed facilities at the mine and mill site are illustrated in Figures 1-3 and 1-4, respectively.

The primary ore mined at the facility is bastnasite, a light-brown carbonate mineral that is significantly enriched with 15 of the lanthanide elements. The bastnasite ore is mined from an open pit. Approximately 3,300 tons per day of overburden (waste rock containing no bastnasite) and 1,800 tons per day of bastnasite ore are extracted from the open pit, approximately 250 days per year. Overburden is transported to the Overburden Stockpile for disposal.

The ore is crushed and blended at the Crushing Plant, and then conveyed to the mill. At the mill, the crushed ore is ground further with a ball mill and sent to the Flotation Plant to separate the bastnasite from the gangue minerals. The primary product of the flotation process is a bastnasite concentrate, which is filter-dried and either packaged to be sold as a product or transported to the Separations Plant for further refinement. Four procedures are used at the Separations Plant to separate the major products from the ore. First, roasting heats the ore. Next, an acid solution dissolves selected lanthanides in the leaching process to acquire cerium concentrate. Third, solvent extraction further purifies the product and extracts europium. An additional solvent extraction occurs at the Specialty Plant to produce a variety of relatively small volume products, such as yttrium and neodymium oxide. Last, precipitation allows for recovery of lanthanide carbonate and lanthanum concentrate. Effluent is then moved to the waste water system, through the thickener, and along a pipeline to the evaporation pond. All of these operations require a series of ponds and pads for storage of product and feed stock. Other ponds are used to control stormwater runoff and infiltrate treated domestic water (Environmental Solutions, Inc. 1994).

The material stored in onsite developed water impoundments include flotation tailings, residual liquids from the flotation process, plant waste, intermediate feed stocks, and product.

In addition to high levels of lanthanide metals, the bastnasite ore body tends to have elevated levels of barium, lead, manganese, strontium, thorium, and zinc. Radionuclides also occur naturally in the ore body and may be concentrated at different stages of mine operations. The tailings and product storage pond liquids generally have high chloride and total dissolved solids (TDS). Nitrate is also elevated in some of the wastewater. The product storage ponds often exhibit low pH. Lignosulfonate (pine pitch used in the ore flotation process) may be present in the North Tailings Pond.

1.2.3 Topography

Onsite elevations range from 4,500 to 5,125 feet above mean sea level (msl); however, most of the site is in the range of 4,600 to 4,900 feet above msl (Lilburn Corporation 1991). The elevation of Clark Mountain, located nearby, is 7,903 feet.

1.2.4 Climate

The mine and mill site is located in the Mojave Desert and the climate at the site is characterized as arid to semi-arid. Annual temperatures range from 0 to 120 degrees Fahrenheit. Precipitation averages about 8 inches per year (ENSR 1996). Most precipitation falls between November and March, but there are occasional summer thunderstorms with heavy rainfall and flash floods. During winter some of the precipitation falls as snow. Nearly 50 percent of the winds in the Mountain Pass region come from the south through west-southwest sectors, and wind speeds average from 6 to 13 miles per hour (ENSR 1996).

1.2.5 Geology

Mountain Pass mine and mill site is located along the southern extent of the Clark Mountain Range, on a fault block of Precambrian rock separating the Shadow Valley and Ivanpah Valley alluvial basins. A geologic map of the mine and mill site can be seen in Figure 1-5.

A complex assemblage of Precambrian metamorphic and igneous rocks is present at the Mountain Pass mine and mill site. The older metamorphic rocks consist primarily of granitic gneiss. The main igneous rock at the mine, which has intruded the older metamorphic complex, consists of a shonkenite-syenite rock and carbonatites, intrusive carbonate rocks (TRC 1998a). Carbonatites are composed primarily of calcite and barite. The lanthanide-bearing minerals at the Mountain Pass mine and mill site are associated with the carbonatites (TRC 1998a); the tabular ore body at Mountain Pass mine and mill site is greater than 200 feet thick in areas.

The natural overburden of the Mountain Pass mine and mill site consists of Quaternary age alluvium and debris flows. The overburden extends up to depths of 800 feet below the surface (Steffen, Robertson and Kirsten, Inc. 1985). These deposits are composed of poorly sorted, pebble- to boulder-sized clasts in a sandy, clayey matrix. These deposits are usually firmly cemented (when encountered during drilling) with calcareous mud and exhibit low hydraulic conductivities compared with fractured bedrock or shallow alluvial deposits (GSi/Water 1991).

Young alluvial deposits and gravels occur in Wheaton Wash, Farmer's Wash, and other drainages, which dissect the older alluvium and bedrock. These deposits are less than 30 feet thick and consist of moderately- to well-sorted pebbles and cobbles within a fine to medium sand matrix.

1.2.6 Hydrology

Surface runoff occurs in the usually dry drainages during thunderstorm activity and flows toward the southeast. No natural perennial lakes, ponds, or streams exist at the mine and mill site.

Groundwater beneath the mine and mill site generally flows south and then both east and west below the two major drainages located along the southern edge of the mine. The southwestern portion of the site drains through Western Drainage, which then drains westward into Upper Kingston Valley Basin. The eastern portion drains through Wheaton Wash and then eastward into Ivanpah Valley Basin (TRC 1998a). Groundwater surfaces as springs in major onsite drainages (e.g., Jack Meyer's Pond Spring, 17 Spring) and at offsite springs (e.g., Roseberry Spring in Wheaton Wash).

Mine pit dewatering and corrective action pumping have affected ground water levels at the site. Superimposed on the regional groundwater system is a semi-perched system affected by the saturated tailings. There appears to be an interconnection between these systems related to fractures in the bedrock. Based on observed large head differences at some locations, this interconnection appears to be discontinuous (TRC 1998a).

The groundwater is generally shallow, less than 10 feet deep, in the wash areas and significantly deeper, up to several hundred feet, below the ridges and in the western portion of the site. Groundwater flow rates at the site are highly variable due to lithologic differences and heterogeneities such as the interconnected nature of the fractures. Typical groundwater flow velocities are estimated to range from 4 to 5 feet/day in shallow alluvium and fractured bedrock; from 0.03 to 1 foot/day for moderately fractured bedrock and old alluvium/debris flows; and from negligible to 0.02 foot/day for slightly fractured bedrock (Environmental Solutions, Inc. 1994).

1.2.7 Habitats

The Mountain Pass mine and mill site contains several habitats that are characteristic of the Mojave Desert. The mine and mill site is dominated by two subassociations of Mojave Desert scrub: Blackbrush-Joshua Tree and Blackbrush-Juniper.

The western third and undisturbed portions of the central third of the mine and mill site is dominated by blackbrush with an overstory of Joshua trees. The eastern third of the mine and mill site is dominated by blackbrush with an overstory of Utah juniper trees.

Both of these subassociations of Mojave Desert scrub are characterized by open, bare ground with scattered assemblages of broad-leaved evergreen or deciduous microphyll shrubs. Blackbrush (*Colegyne ramosissima*) is the dominant plant in the shrub layer. Creosote bush (*Larrea tridentata*) is also typical of desert scrub habitat, as are a wide variety of cacti (e.g., *Opuntia* spp.), yucca (*Yucca* spp.), and grasses and forbs. Representative resident wildlife species are Mojave rattlesnake (*Crotalus scutulatus*), common kingsnake (*Lampropeltis getulus*), western whiptail (*Cnemidophorus tigris*), collared lizard (*Crotaphytus collaris*), side-blotched lizard (*Uta stansburiana*), Gambel's quail (*Callipepla gambelii*), black-throated sparrow (*Amphispiza bilineata*), house finch (*Carpodacus mexicanus*), deer mouse (*Peromyscus maniculatus*), desert wood rat (*Neotoma lepida*), black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus audubonii*), and coyote (*Canis latrans*).

Desert scrub intergrades with Joshua tree woodland at the mine and mill site. In such areas of overlap, Joshua trees (*Yucca brevifolia*) provide vertical structure to desert scrub habitat. Joshua tree woodland consists of an open woodland of widely scattered Joshua trees and a low community of broad-leaved evergreen and deciduous shrubs, with little herbaceous understory. Joshua trees coexist with California juniper (*Juniperus californica*) and Mojave yucca (*Yucca schidigera*). Common shrub species include sagebrush (e.g., *Salazaria* spp.), blackbrush (*Coleogyne ramosissima*), creosote bush, and California buckwheat (*Eriogonum fasciculatum*) (Mayer and Laudenslayer 1988; Ornduff 1974). Vertebrate species are similar to those found in desert scrub; however, the presence of Joshua trees would provide habitat for additional species such as desert spiny lizard (*Sceloporus magister*), desert night lizard (*Xantusia vigilis*), and cactus wren (*Campylorhynchus brunneicapillus*).

At Mountain Pass, desert scrub habitats also grade into Juniper-blackbrush habitat. According to biological surveys (Lilburn 1990-1993), Juniper-blackbrush habitat is found in eastern areas of the mine and mill site (east of Farmer's Wash). Based on available habitat maps, the proposed East Tailings Ponds will be situated in Juniper-Blackbrush habitat. Juniper-blackbrush habitat is likely to support reptile, bird, and mammal species similar to those found in adjacent desert scrub habitat.

Desert wash habitat is also found in large drainages at the mine and mill site (e.g., Farmer's Wash) and in nearby Wheaton Wash. Sandy soils, spiny shrubs, and denser and taller vegetation are characteristic of this habitat. Plants commonly found in desert wash include tamarisk (*Tamarix* spp.), mesquite (*Prosopis glandulosa* var. *torreyana*, desert broom (*Lotus scoparius*), and desert-willow (*Chilopsis linearis*). Groundcover consists of a variety of grasses and forbs. The vertical structure and dense shrubbery support a variety of bird species at higher densities and diversity relative to surrounding desert habitats (Mayer and Laudenslayer 1988). In addition, the dense vegetation provides food and refuge for other desert wildlife.

Intermittent freshwater aquatic habitat is present at the mine and mill site. Freshwater aquatic habitat provides habitat for aquatic insects and a potential source of drinking water for wildlife. Some intermittent springs and ponds at the mine and mill site are fringed by herbaceous grasses and forbs, but few springs observed during the 1999 HHERA sampling effort were found to support dense stands of emergent vegetation (Tetra Tech Inc. 2000a).

Highly disturbed, industrial land use is the dominant "habitat type" at the overburden stockpile, roadways, open pit mine, warehouse, and in areas surrounding the mill, separations, specialty, and other ore processing facilities. These areas are characterized by either the lack of vegetation or the presence of disturbed landscapes with introduced plant species. This habitat type provides little or no attractive refuge or foraging habitat compared to surrounding, minimally disturbed desert habitats. Wildlife that may be observed in this habitat are likely to be exotic species and transient visitors that are tolerant of human activity and typical of highly disturbed industrial areas.

1.2.8 Land Use

Mountain Pass mine and mill site is in a portion of San Bernardino County that is classified as a rural development category for planning purposes. Such a land designation is consistent with agriculture, general open space, watershed management, isolated developments, or parcels of 20 acres or larger (ENSR 1996). Under the county's general plan, three Official Land Use Districts (OLUDs) are assigned to the mine and associated facilities. Planned development allows for a combination of residential, commercial, industrial, agricultural, open space/recreation uses, and similar uses. Resource conservation allows for open space and recreation, single-family homes on very large parcels, and similar uses. General commercial use provides for stores, lodging services, office and professional services, recreation and entertainment services, wholesaling and warehousing, contract/construction services, transportation services, open lot services, and similar uses.

The small community of Mountain Pass is located approximately 0.4 miles west of the mine site main gate. Approximately 35 people live in the community, including employees of the California Department of Transportation (Caltrans) and the California Highway Patrol (CHP). Because of the limited housing in the vicinity of the mine, the majority of mine employees commute from nearby communities, such as Henderson and Las Vegas, Nevada, and Baker, California (ENSR 1996).

Except for a small U.S. Post Office located near the main gate of the mine and mill site, no commercial services are located at Mountain Pass. The primary source of employment at Mountain Pass is Mountain Pass Mine. Historically, under normal operating conditions, approximately 300 workers were employed at the mine and mill site (ENSR 1996). Currently, about 50 workers are employed at the facility. The number of employees is likely to return to historical levels, if the mine returns to full operating capacity. In addition to the mine and post office, a Caltrans maintenance office is also located in Mountain Pass. Seven Caltrans employees are stationed at this maintenance office and six live in Mountain Pass (ENSR 1996; M. Underwood pers. comm.). Three CHP officers also have homes at Mountain Pass.

Mountain Pass Elementary School is located on land owned by Molycorp and is situated near the main gate of the mine and mill site. The school serves grades kindergarten through six. Students live in Mountain Pass, Nipton, and surrounding areas. The school is part of the Baker Valley Unified School District. Enrollment in the spring of 1999 was 14 (M. Underwood pers. comm.), although facilities are available to teach a student body of 68 (ENSR 1996).

1.3 SUMMARY OF THE PROPOSED PROJECT

Based on known ore reserves, a 30-year mine expansion project (Proposed Project) has been proposed for the mine and mill site (Molycorp 1999). Under the future site expansion scenario, a total of 1,370 acres will be disturbed, comprising approximately 65 percent of the site. The proposed expansion consists of the following activities (Table 1-2):

- Increase the existing open pit mine from 55 acres to 118 acres and deepen it from a depth of 350 ft to 770 ft;
- Increase the existing West Overburden Stockpile Area from approximately 70

acres to 160 acres and from a crest height of 4,950 ft to 5,100 ft above mean sea level (msl);

- Increase the existing North Overburden Stockpile Area from approximately 18 acres to 145 acres and increase the crest height to 5,200 ft msl;
- Construct a lined 174-acre East Tailings Storage Pond - the embankment would cover an additional 48 acres and have a final height of approximately 4,650 ft msl;
- Construct a lined 170-acre onsite evaporation pond;
- Relocate the existing mill/flotation pond and crusher to the north of the existing Separations Plant;
- Construct access/haul roads to the East Tailings Storage Pond and other new facilities; and
- Continue concurrent reclamation of existing disturbed areas.

Under the proposed expansion, the mill, separations, specialty, and other ancillary facilities will be processing at full capacity (2,000 tons of ore per day). For the first five years, fresh ore will be delivered to the primary crusher at a rate of approximately 450,000 tons per year. After year five of the 30-year expansion, mining of fresh ore is expected to increase to 630,000 tons per year. Overburden removal will increase accordingly, up to 5,370 tons per day. This will result in expansions of the West Overburden Stockpile through year 11, and of the North Overburden Stockpile, from years 11 through 30.

For tailings disposal, the East Tailings Storage Pond will take over the function of the North Tailings Storage Pond (P-16). With a 19 million ton tailings capacity, the East Tailings Storage Pond will consist of a lining system, embankments, pipelines and pumping systems, an access road, perimeter surface water diversion channels, and spillways for each embankment phase. A vadose zone monitoring and leak detection system is also planned for this new tailings storage area. Tailings will be placed in the storage area by hydraulic deposition, with the aid of spigots and/or cyclones. From the mill and flotation plant, tailings will be pumped to the East Tailings Storage Pond through a double-lined pipe system. Product storage ponds, however, are not changed under any proposed expansion alternative.

Modifications will also be made to current wastewater management practices. Under the expansion project, wastewater will be transported to and treated in lined, onsite evaporation ponds, which will replace the New Ivanpah Evaporation Pond. A membrane filtration system will be utilized to maximize water reuse. Under normal operating conditions, treated water will be used throughout mineral recovery plants and for dust control. Excess treated water will be distributed over a land application area and removed by evaporation. Additional evaporation ponds may be constructed if necessary.

Risks potentially associated with the aforementioned planned operations will be assessed under the future site expansion scenario in the HHERA.

1.4 SUMMARY OF THE RISK SCENARIOS

The HHERA assesses risk for three scenarios: baseline, future expansion, and reference scenarios.

Baseline Scenario. Risk assessments of the baseline scenario evaluate potential risks that may arise as a result of radioactive and nonradioactive constituent releases occurring during mining and milling operations prior to 1 January 1998. Risk assessments for the baseline scenario assume that:

- The mill, separations, specialty, and other ancillary facilities are processing at full capacity: 2000 tons of ore per day (80% of the bastnasite is processed at separation facilities; the remaining 20% of the bastnasite is allocated to sales);

- Groundwater at the mine and mill site has not been remediated.

This assessment is analogous to a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) baseline risk assessment. Data characterizing conditions at the mine site in the time frame of October 1997 to 1 January 1998 are used to determine exposures to radioactive and nonradioactive constituents of concern.

Future Expansion Scenario. Risk assessments of the future site expansion scenario evaluate potential future risks that may arise as a result of radioactive and nonradioactive constituent releases occurring during mining and milling operations associated with the proposed mine expansion project. Given the revised expansion project description, risk assessments for the future site scenario assume that:

- The mill, separations, specialty, and other ancillary facilities are processing at full capacity (2,000 tons of ore per day);
- Wastewater is transported to and treated in a lined, onsite evaporation pond;
- The overburden stockpile area is increased;
- The new lined East Tailings Storage Pond meets regulatory compliance—North Tailings Storage Pond and Seepage Collection Pond have been remediated, closed, and are in compliance with environmental regulations;
- Product storage ponds are not changed under any proposed expansion alternative;
- Unremediated conditions at Mountain Pass Mine may be used to represent future site expansion scenario conditions for the Proposed Project (e.g., sediment quality at the North Tailings Pond may be used to evaluate future sediment quality at the proposed East Tailings Pond)—information that supports the use of current conditions in assessing future site expansion conditions at a particular area is provided later in this HHERA report.

This risk assessment provides information needed to support the development of the EIR for the Mountain Pass Mine Expansion Project.

Reference Scenario. Risks associated with the reference scenario are intended to provide a point-of-reference for comparisons with proposed expansion project activities. Risk assessments of the reference scenario will assume that conditions would reflect those that may have occurred onsite in the absence of mining activity:

- Soils and groundwater are comparable to background, naturally occurring conditions in the vicinity of Mountain Pass Mine;
- Airborne constituents would be derived from naturally occurring soils (i.e., background) within the boundaries of the Mountain Pass Mine property;

This information provides a point-of-reference for interpreting predicted future site expansion scenario risks posed by the proposed mine expansion.

1.5 ASSUMPTIONS USED TO SCOPE THE HHERA

The identification of areas and receptors for which risk assessments were conducted is based on three assumptions (Figure 1-6):

- Operations are in compliance with regulatory requirements;
- Exposures to potentially hazardous constituents are being monitored, assessed, and managed under established programs; and
- Areas or receptors that would not be affected by the proposed expansion project are poor differentiators for evaluating the proposed expansion activities.

These assumptions are the basis for the three key decisions in the scoping decision tree and are discussed below.

Table 1-3 summarizes the scope of human health and ecological risk assessments conducted for the Mountain Pass Mine facility. Conceptual site models further identify receptors and exposure scenarios assessed (see Sections 2 and 3).

Assumption #1: Operations are in compliance with regulatory requirements.

The HHERA supports evaluations of areas of the mine facility affected by expansion plans, and not for areas where regulatory compliance is completed, underway, or planned as part of the Proposed Project or continuing activity [as defined in "Mountain Pass Mine Project Description Summary" (Molycorp 1999)].

Assumption #2: If exposures are being monitored, assessed, and managed under established programs, no analysis of risks will be conducted.

Risk assessments for the baseline and future scenario were not conducted for areas, exposure pathways, or receptors where a health and safety program has already been established. For example, mine and mill workers are monitored by an industrial hygiene program regulated by the MSHA and Cal OSHA. These regulatory agencies have established industrial health criteria for radiation and chemical exposures; therefore, no human health risk assessment of the baseline scenario was conducted for mine and mill workers.

Assumption #3: Areas or receptors that would not be affected by the Proposed Project are poor differentiators for evaluating proposed expansion activities.

Areas that are unaffected by proposed expansion activities pose the same risk irrespective of any expansion activity, and thus are poor differentiators for evaluating relative risks among possible expansion alternatives. Therefore, if an area is unaffected by proposed expansion activities, no assessment of potential future site expansion risks is conducted for the area. For example, the spatial extent, quality of wildlife habitats, and concentrations of dissolved constituents at the Lanthanide Storage Ponds are likely to be unaffected by the Proposed Project. Therefore, no ecological risk assessments for the future site expansion scenario were completed for the Lanthanide Storage Ponds[1].

1.6 DATA USED IN THE HHERA

Data compiled from Molycorp, Molycorp contractors, participating regulatory agencies, and newly collected data were used in the HHERA. These data were identified in a six-step process, as summarized herein. First, documents characterizing conditions at the mine and mill site were identified. Second, the reported constituent concentrations for groundwater, surface water, soils, and air were evaluated for completeness and usability. Factors considered were environmental media sampled, location of sampling, sampling date(s), parameters sampled, number of samples, sampling/analytical methods, and quality assurance/quality control (QA/QC) data. Third, an assessment of the data quantity and quality was provided to the TWG. This assessment consisted of the identification of environmental media, receptor information, and toxicity data that were sufficient to conduct the HHERA for the mine and mill site, as reported in the *HHERA Work Plan* (Appendix I.T1, *Task 1:Data Compilation and Review* and Appendix I.T3, *Task 3: Develop Conceptual Site Model*). Key data gaps were also identified and reported to the TWG in the *Sampling Work Plan* (Tetra Tech 1999). In the fourth step of the data identification process, the TWG and Tetra Tech agreed on the scope of additional sampling necessary to fill the identified data gaps (Tetra Tech 1999). The primary method used to acquire additional data consisted of sampling soil, sediment, and surface water on and in the vicinity of the mine and mill site. The results of the sampling efforts are provided in the *Field Summary Report* (Tetra Tech 2000a). The TWG participated in, reviewed, and approved the results of this fifth step of the data acquisition process. Finally, the newly acquired data were integrated with data identified from other sources to serve as the dataset for use in characterizing risks in the HHERA.

[1] Risks will be evaluated for the baseline scenario at Lanthanide Storage Ponds.

Data used to characterize constituent concentrations in each environmental medium at the mine and mill site are summarized in Table 1-4 and are described below (see also Appendix II, *Data*). Data are reported for each area of concern (AOC) where the co-occurrence of released constituents and human and wildlife receptors is likely.

1.6.1 Soils

Soil samples were collected by Tetra Tech, Inc. (hereon referred to as Tetra Tech) at 14 potentially affected areas at the mine and mill site and analyzed for inorganic constituents and radionuclides. Reference soil samples were also collected by Tetra Tech at seven different locations representing different background soil types. Data from soil samples collected by Tetra Tech (2000a) were supplemented in part with data from TRC, which had been collected in drainages to support characterizations at the mine and mill site.

Soils collected from the top inch of soils at the school were assumed to be the likeliest for school children to contact; thus, these samples were used in the human health risk assessment (see Section 2.0). Soils collected from the top six inches of soils were assumed to be the likeliest for residents, visitors to the mine, plants, soil invertebrates, and wildlife to contact. Only surface soil (i.e., soils less than six inches bgs[2]) data were used in the ecological risk assessment (see Section 3.0).

1.6.2 Sediment

Tetra Tech (2000a) sampled sediments at two onsite springs, two onsite ponds, and one reference area and analyzed for inorganic constituents and radionuclides.

1.6.3 Surface Water

Surface water samples collected and analyzed by Tetra Tech (2000a) at eight onsite ponds and springs. Samples were analyzed for all inorganic constituents and radionuclides. Surface water data from Geomega were reviewed and confirm Tetra Tech (2000a) data. Geomega data, however, were not used in the HHERA due to small sample sizes (n=1 to n=3) and few analyzed constituents.

1.6.4 Groundwater

Data from groundwater wells in six AOCs sampled by Molycorp were used in the HHERA. Additionally, one groundwater well was considered unaffected by site activities and used as reference groundwater. All constituent types were analyzed for in groundwater samples. Although data were available from sampling events in 1985 to 1999, only recent sampling data (i.e., 1998 to 1999) were used in the HHERA.

1.6.5 Indoor Carpet Dust

In June 1999, the State Department of Health Services (DHS) collected indoor carpet dust samples from the Mountain Pass Elementary School. Samples were analyzed for metals, lanthanide metals, actinide metals, and radionuclides. These data were used to evaluate potential risks to school children from exposure to indoor carpet dust, and were also used to estimate concentrations of constituents in indoor carpet dust at CHP/Caltrans residences.

1.6.6 Future Soil (Deposition)

Deposition and mixing of airborne particulates with soil was modeled by ENVIRON (June 26, 2000) for future expansion activities. Metals, lanthanide metals, and radionuclide concentrations were modeled for three AOCs (including two locations in one of the AOCs) at the mine and mill site. Results of these analyses were used as predictions of incremental increases in constituents in soils due to future airborne particulate deposition.

1.6.7 Air

Constituents in air at the mine and mill site were modeled by ENVIRON (2000b) for three AOCs (including two locations in one of the AOCs) and were used to evaluate potential baseline and

[2] bgs = below ground surface

future risks to human receptors from inhalation of airborne metals, lanthanide metals, organics, and radionuclides.

1.6.8 Future Onsite Evaporation Ponds

Predicted concentrations for surface water and solids at the proposed future onsite evaporation ponds were calculated using information and models provided in Appendix D.6, *Calculations of Exposures at the Onsite Evaporation Pond* of Appendix I, *HHERA Work Plan*. Data collected at the NIEP were not used as surrogate data for the proposed onsite evaporation pond because of four key differences between the proposed onsite evaporation ponds and NIEP:

1. The future operation will be modified to use less water, thus allowing more efficient particle separation from the wastestream and allowing for the smaller diameter pipeline.
2. The onsite evaporation ponds will only have a pipeline of approximately 1-mile in length and will be pigged/scoured on a weekly basis, thus promoting less scale formation.
3. The future operation will treat and filter the wastestream prior to discharge into onsite evaporation ponds.
4. The proposed onsite ponds will be lined to prevent seepage—the pond bottom will eventually be mined of the precipitating salts.

To ensure a protective assessment, predicted concentrations for surface water and solids at the onsite evaporation ponds assumed no treatment of the wastestream prior to entering the onsite evaporation ponds and that wildlife exposures occur at the most concentrated onsite evaporation pond. All input values and model used to predict exposures at proposed future evaporation ponds were reviewed and approved by the TWG (for further details, see Appendix D.6, *Calculations of Exposures at the Onsite Evaporation Pond* of Appendix I, *HHERA Work Plan*).

1.7 DOCUMENT ORGANIZATION

This document examines potential risks that may occur as a result of exposure at or near the Molycorp Mountain Pass Mine and Mill site only. As mentioned previously, a separate document will discuss the potential for adverse human health and ecological effects that may occur as a result of exposure along the wastewater pipeline and at New Ivanpah Evaporation Pond.

The remainder of the HHERA report is organized as follows:

- Section 2.0 describes potential health risks to human receptors under baseline and future expansion scenarios.
- Section 3.0 describes potential risks to aquatic and terrestrial biota (i.e., plants, invertebrates, reptiles, birds, and mammals) under baseline and future expansion scenarios.
- Section 4.0 states the conclusions of the risk assessment for the mine and mill site.
- Section 5.0 lists references used in the HHERA report.

Appendices provide a more detailed discussion of specific topics (*e.g.,* groundwater human health risk assessment) and details of the risk calculations. Appendices include:

- Appendix I: HHERA Work Plan and all responses to comments on the Work Plan
- Appendix II: Data used in the HHERA and summary statistics for soils, sediment, surface water, and groundwater
- Appendix III: Reference (background) characterization
- Appendix IV: Human health risk estimates and supporting documentation
- Appendix V: Groundwater human health risk assessment

- Appendix VI: Ecological risk estimates and supporting documentation
- Appendix VII: Comparison of baseline air dispersion modeling results to monitoring data.

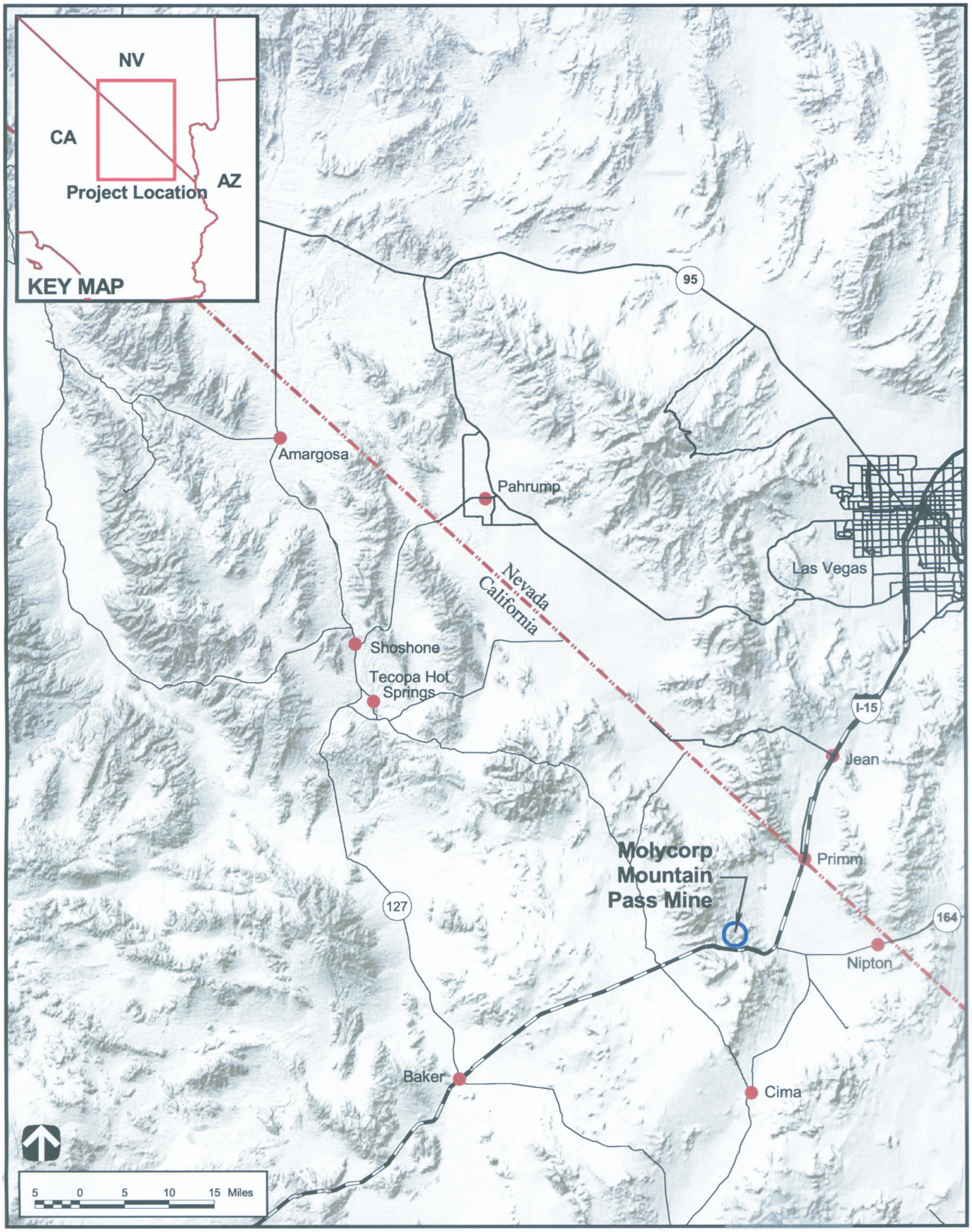
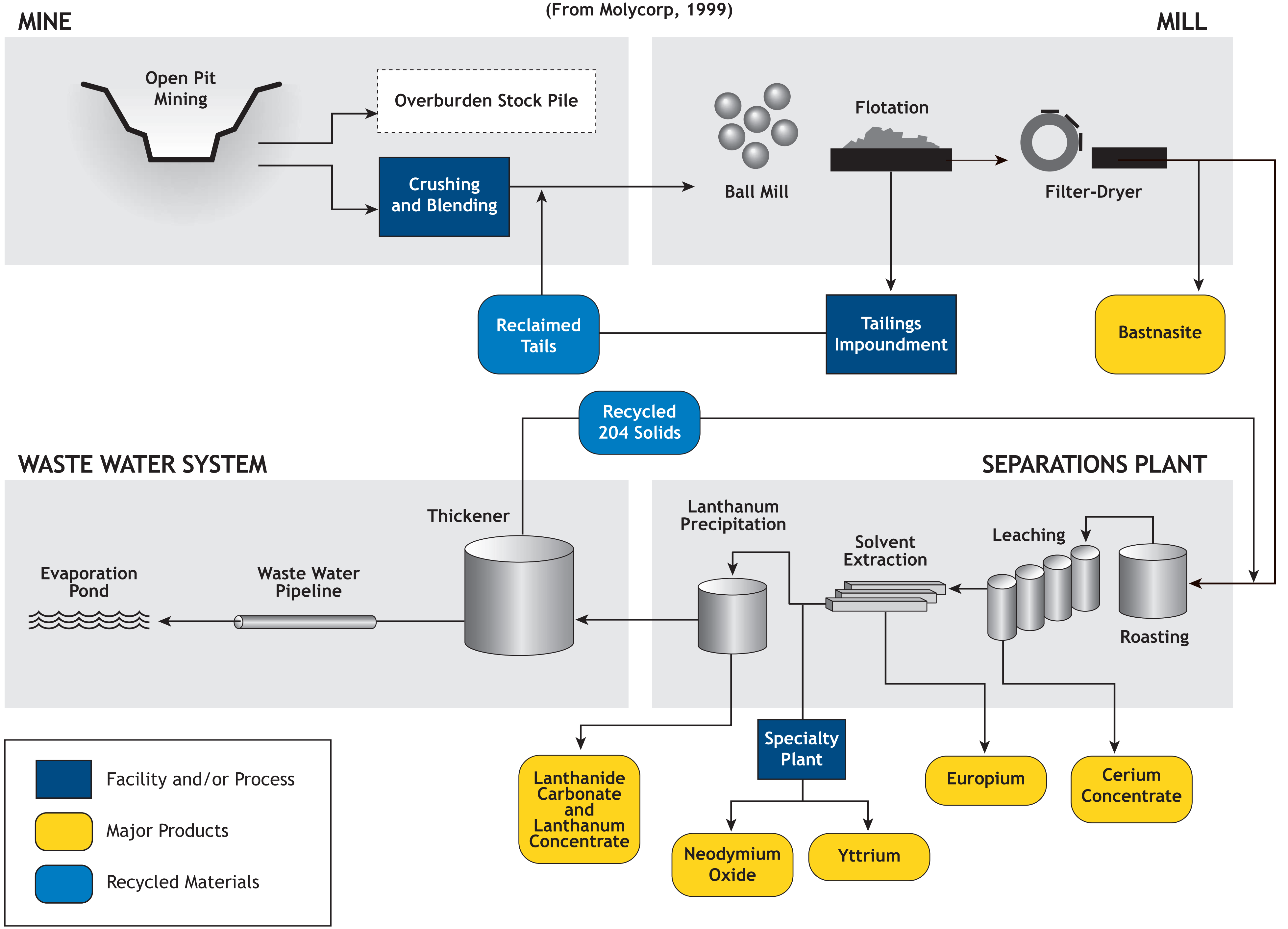


Figure 1-1. Vicinity Map.

Figure 1-2
Mountain Pass Mine Production Overview
(From Molycorp, 1999)



10077-05 Mountain Pass.ai

WH	Warehouse
HR	Haul Road
OS	Overburden Stockpile
WT	Windblown Tailings
P16	North Tailings Pond
P25A	Lanthanide Storage Pond
P25B	Lanthanide Storage Pond
P28	Lanthanide Storage Pond
AP	Administration Pond
MPES	Elementary School
CHPR	Caltrans Residences

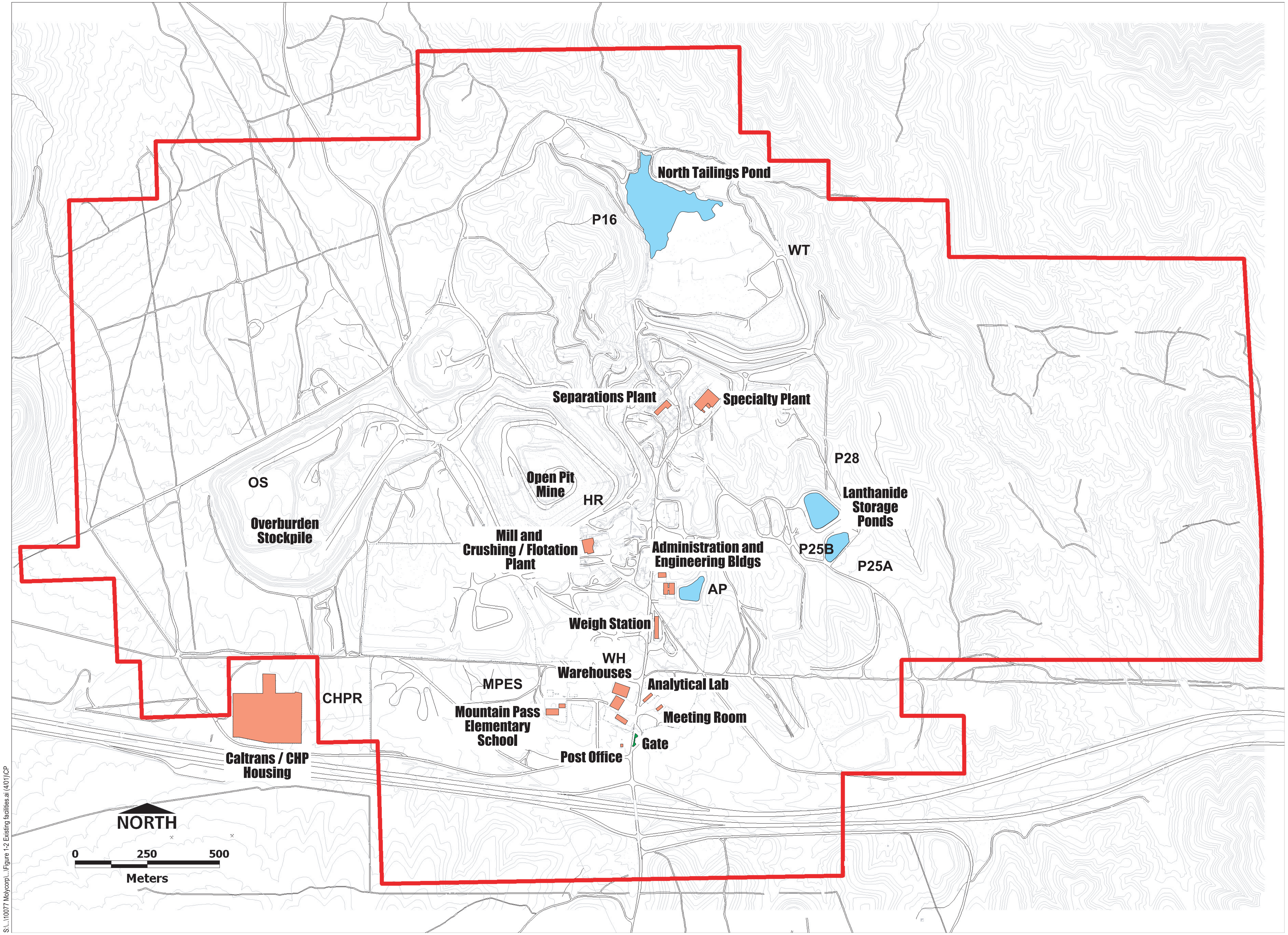


Figure 1-3. Existing facilities at the Mine and Mill Site.

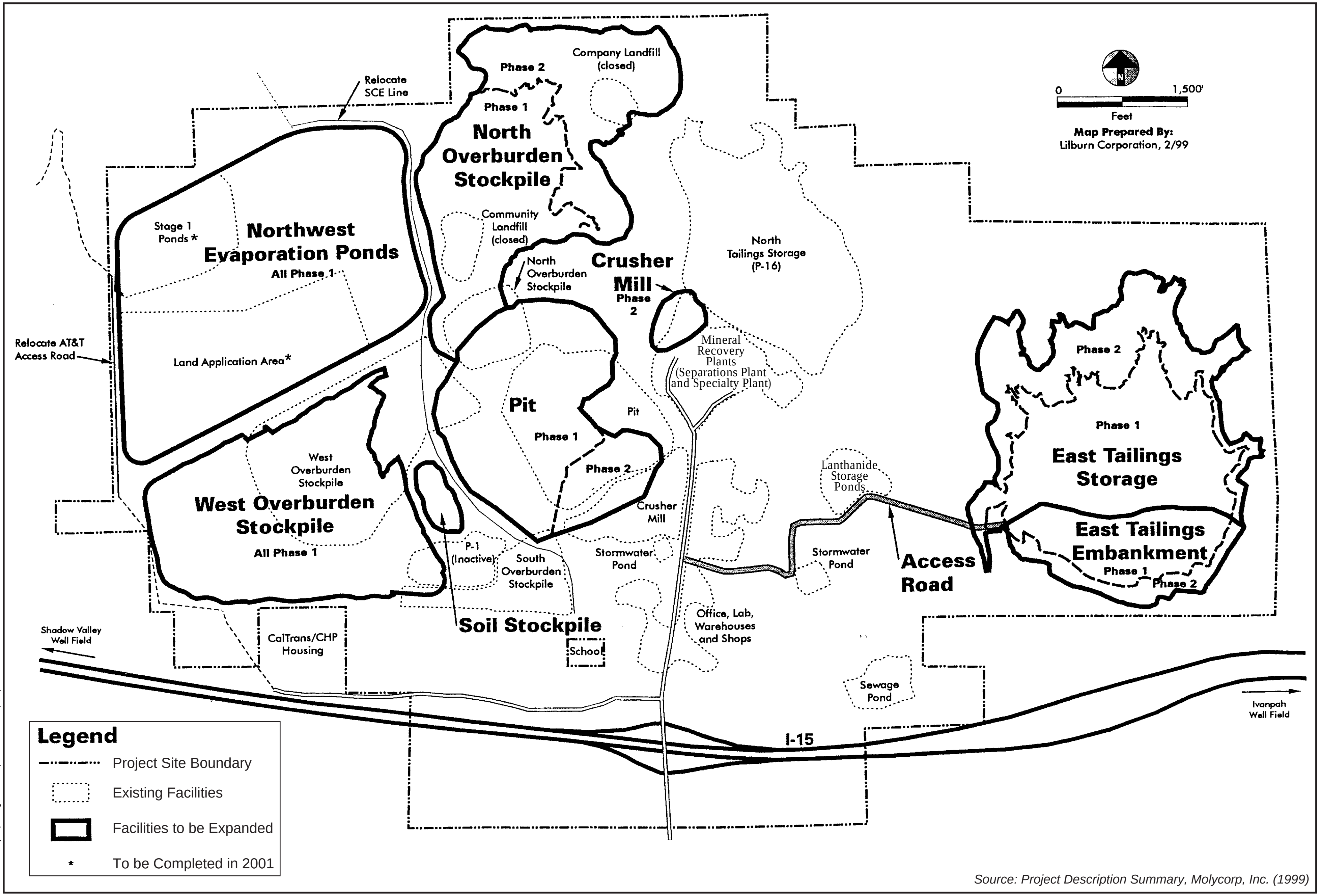


Figure 1-4. Proposed facilities at the Mine and Mill Site.

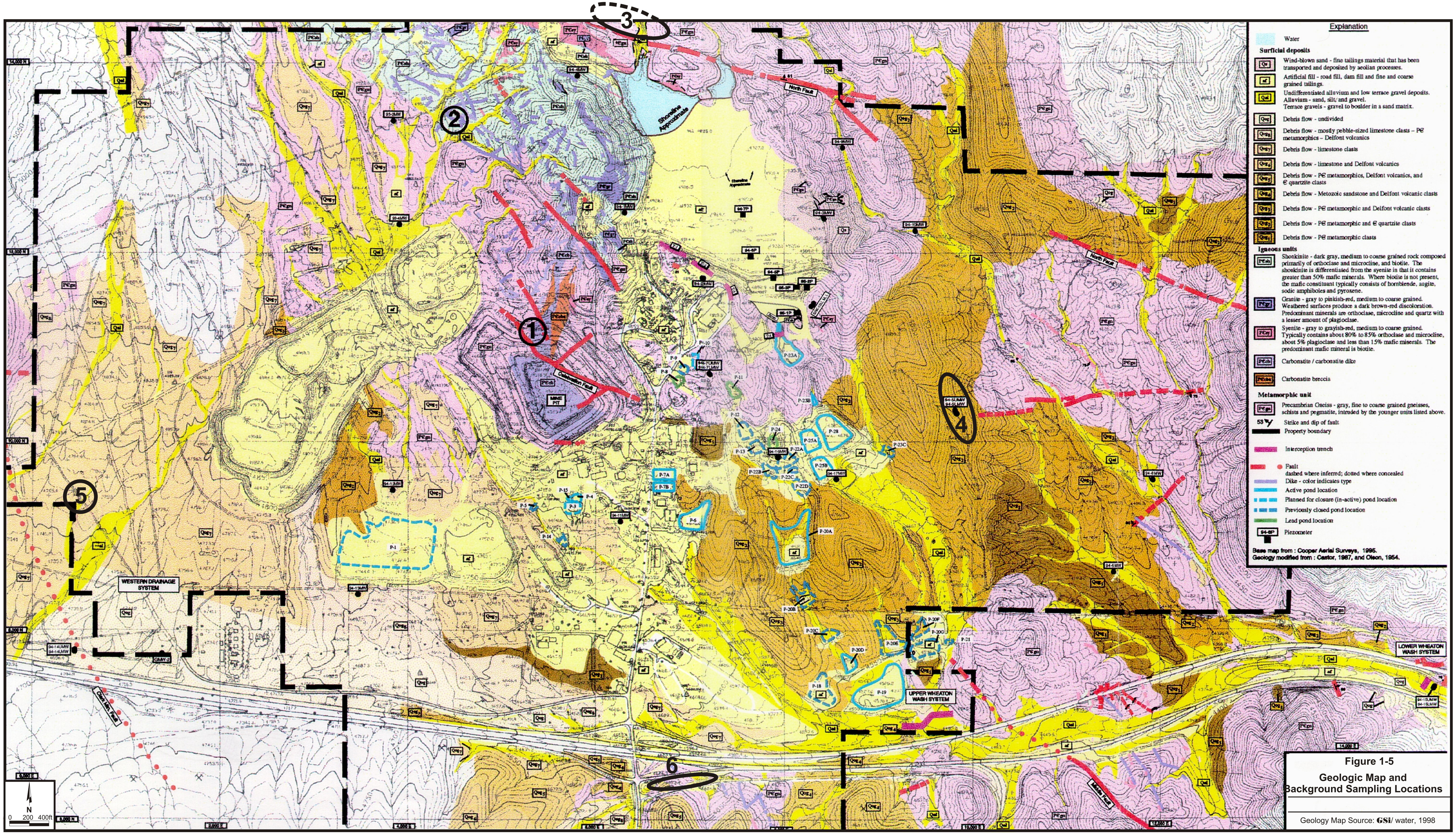


Figure 1-5
Geologic Map and Background Sampling Locations

Geology Map Source: GSi/ water, 1998

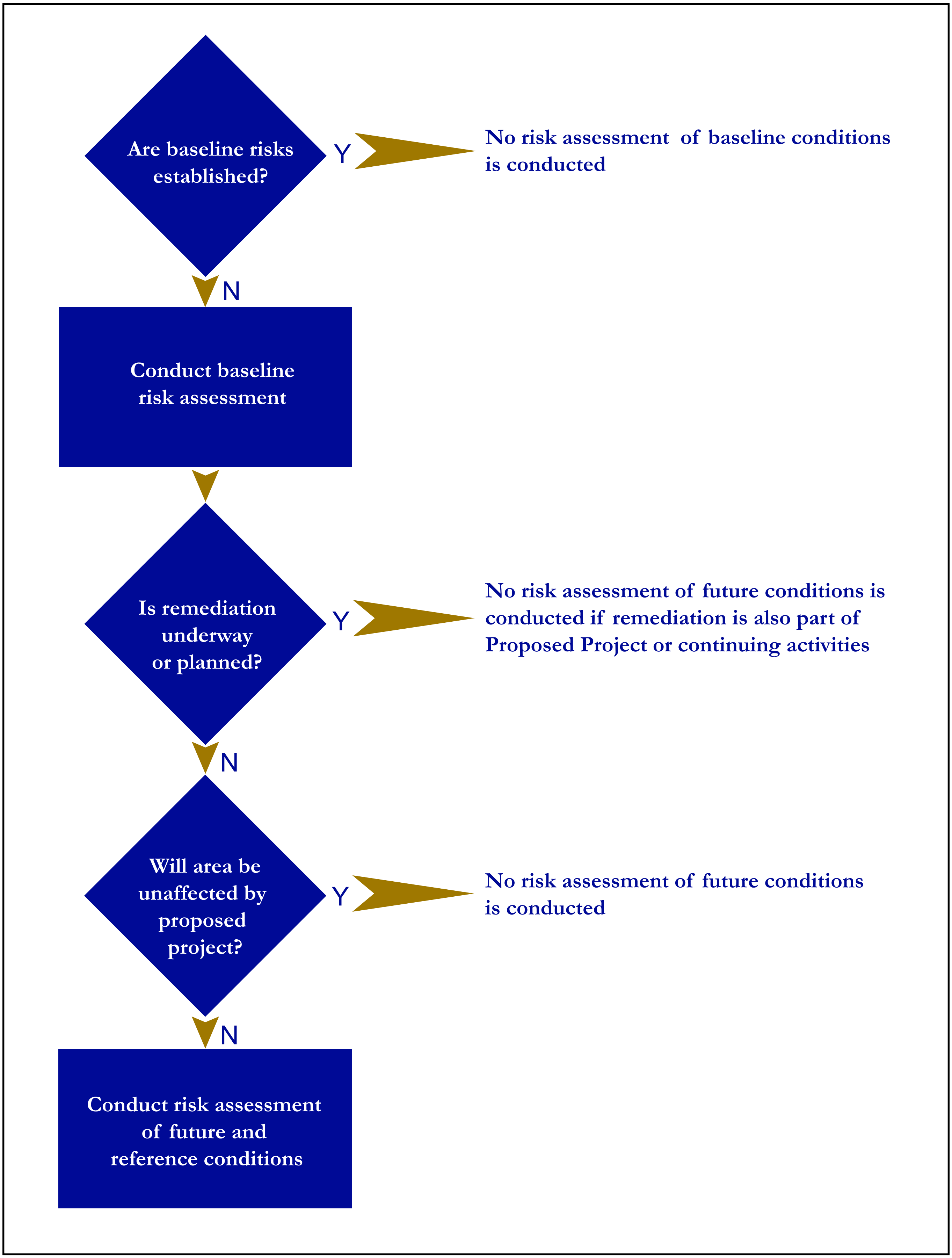


Figure 1-6. HHERA Scoping Decision Tree

Table 1-1
Technical Work Group (TWG) Membership
by Affiliation

TWG Members

Bureau of Land Management (BLM)
- Karl Ford
- James Byrd

California Department of Fish and Game (DF&G)
- William Paznokas*
- Donna Davis

California Department of Health Services, Environmental Health Impact Branch
- Marilyn Underwood
- Gina Margillo (public outreach)

California Department of Health Services, Radiological Health Branch
- Ed Bailey
- Steve Hsu
- Jeff Wong

California Department of Toxic Substances Control (DTSC)
- Glen Forman*
- Michael Schum
- Aaron Yue

California Regional Water Quality Control Board (RWQCB)—Lahontan
- Cindi Mitton*
- Curt Shifrer

Dynamac [contractor for BLM]
- Bob Dover*

Ecology & Environment (E&E) [contractor for NPS]
- Tom Angus*
- Carl Mach
- Colin Moy
- Carl Stineman
- Diana Wong

ENSR
- Bill Gorham, TWG Chair

McDaniel Lambert [contractor for Molycorp]
- Chuck Lambert

Molycorp
- Robin Norman*
- Shannon Rogan*
- Bill Sharrer

National Park Service (NPS)—Mojave
- Dave Anderson

San Bernardino County
- Randy Scott

U.S. Fish & Wildlife Service (USFWS)
- Charles Sullivan*
- Denise Steurer*
- Lisa Roberts*
- Louise Lampara

Notes:
* = past TWG member

Table 1-2
Summary of Proposed Project Activities (from Molycorp 1999)

FACILITY	Existing[1]	Phase I (Yrs 1-15)[1]	Phase 2 (Yrs 16-30)[1]	Phase 3 (Reclamation)	Comments
MINE AND MILL SITE					
Open pit mine	55	51	12	Reclaim	
North overburden stockpile area	18	61	66	Reclaim	
West overburden stockpile area	70	90	0	Reclaim	• Includes 3 acres of P-1
South overburden stockpile area	21	0	0	Reclaim	
Surface material stockpile	—	vary	vary	Reclaim	
North tailings storage pond (P-16)	90	Reclaim	—	—	
West tailings storage pond (P-1)	10	Reclaim	—	—	
East tailings storage pond	0	165	57	Close & Reclaim	
Onsite evaporation ponds	35[2]	215	0	—	
Relocation of mill/flotation plant	20	—	6	Remove & Reclaim	
Realign SCE power line along west boundary	4	6	—	—	
New access roads	42	20	—	Partially reclaim	
Relocate AT&T access road	3	0	—	—	• Along SCE reailgnment
Relocate Shadow Valley FW pipeline	—	—	—	—	

1 Estimated area in acres
2 Stage I Evaporation Pond constructed in 1999

Table 1-3

Summary of Human Health and Ecological Risks Assessments Conducted for the HHERA

	Baseline		Future		Reference	
Mine Operational Units	HHRA	ERA	HHRA	ERA	HHRA	ERA
Mine and Mill Site	● [1]	● [2]	● [3]	● [4]	●	●
Wastewater Pipeline	●	●			● CL	● CL
New Ivanpah Evaporation Pond	●	●			● CL	● CL

Note:

● = Risk assessments conducted by Tetra Tech

CL = Cleanup (remediation) to negligible risk levels

1 = Exposures of onsite workers are evaluated and managed by an established industrial hygiene program. Baseline conditions were evaluated for onsite and offsite receptors likely to be affected by releases.

2 = Risk assessments of baseline conditions were conducted for potentially affected areas that support (or, are suitable to support) plants, invertebrates, or wildlife receptors, or where the lack of plants, invertebrates, or wildlife is due to the presence of released constituents.

3 = A human health risk assessment was conducted for receptor groups potentially affected by future expansion plans

4 = ERAs were conducted for potentially affected areas that are likely to support plant and wildlife populations. Areas that are unlikely to be affected by proposed mine expansions were not assessed under future conditions.

Table 1-4
Data Used in the HHERA

	Soil	Sediment	Surface Water	Groundwater	Indoor Carpet Dust	Future Soil (Deposition)[1]	Air[2]
No. AOCs sampled	14	4	8	6	1	4	4
No. Reference Areas sampled	7	1	-	1	-	-	-
No. samples							
Metals	2721	500	1459	1130	40	11	11
Lanthanide Metals	1852	401	1107	264	32	1	1
Actinide Metals	390	54	158	80	4	-	-
Other inorganics	19	-	59	366	-	2	4
Organics	-	-	-	210	-	-	21
Radionuclides	5127	216	926	1002	34	4	4
Source(s)	Tetra Tech; TRC	Tetra Tech	Tetra Tech	Molycorp/ Geomega	DHS	ENVIRON	ENVIRON
Date	2000	2000	1999	1998-1999 (1985-99 available)	1999	2000	2000

Notes:

1 Predicted by deposition modeling; no direct sampling occurred.
2 Predicted by air modeling; no direct sampling occurred.

AOC = Area of Concern
DHS = State Department of Health Services

2.0 HUMAN HEALTH RISK ASSESSMENT

The human health risk assessment (HHRA) provides an evaluation of the potential for adverse health effects to occur as a result of exposure to chemical and radiological releases under baseline conditions, proposed future expansion alternatives, and reference conditions for the Mountain Pass mine and mill facility. The human health risk assessment has been conducted to provide technical information in support of the EIR and aid in the selection of the appropriate alternative for future mining operations at Mountain Pass Mine.

The HHRA consists of five basic components:

- Conceptual site model
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Analysis

The risk assessment methodology is based on guidance developed by the USEPA (USEPA 1989a; 1991a; 1992a,b; 1997a,b; 1998a; 2000a), the California Department of Toxic Substances Control (DTSC 1992) and the California Environmental Protection Agency (Cal EPA 1994a, b; 2000). The HHRA is based on a workplan approved by the TWG. The approved workplan (T*ask 4: Human Health Risk Assessment* in Appendix I), describes the factors key to completion of each of the above components of the HHRA, including the conceptual site model, the methodologies for identifying constituents of potential concern, naturally occurring, background (reference) conditions, the potentially exposed receptors, the parameters used to calculate exposures, the toxicity values used in estimating risks, and the risk calculation approach. The approved workplan and supporting materials are provided in Appendix I.

2.1 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) presents information on the sources of environmental releases and the routes by which people may be exposed to potentially toxic and radioactive constituents. A CSM also integrates information on the environmental behavior of the constituents of concern to determine potential exposures of human receptors. Identification of potentially complete exposure pathways is instrumental in constructing a CSM. An exposure pathway describes the course that a chemical takes from a source to an exposed individual. An exposure pathway is considered to be complete when it has all four the following factors: 1) source(s) of chemicals or radionuclide releases to the environment, 2) mechanisms of fate and transport resulting in the release or migration of a chemical or radionuclide in the environment, 3) a point where human receptors may be exposed, and 4) routes of exposure to contaminated media.

2.1.1 Areas of Concern and Reference Background Locations

Areas of concern (AOCs) are defined as areas where human receptors could potentially be exposed to chemicals released through facility activities. As described in Section 1.2.8, there are a limited number of receptors in the immediate vicinity of Mountain Pass mine and mill site. Based on an evaluation of receptors who may have relatively high levels of exposure, three areas of concern were identified for people who could potentially be exposed to releases from the mine and mill site (Figure 2-1):

- Mountain Pass Elementary School
- Mountain Pass residences
- Warehouses on the mine and mill site

For this HHRA, each of these areas of concern is identified by the receptor group potentially exposed to constituent releases, as shown in the conceptual site model (Figure 2-2). The evaluations supporting these determinations are described in Section 2.1.3 and in Appendix I.T2 (*Task 2* in Appendix I).

Several background datasets for soils were determined for use in identifying COPCs. At the mine and mill site, different soil types were identified using Gsi/Water's (1998) geology map of the site and subsequent site visits by Tetra Tech geologists and members of the TWG. The background data sets selected by the TWG for use in screening COPCs in soils are listed in Table 2-1. As can be noted, younger alluvium was identified as a background soil type for use in identifying COPCs in soil for all three of the human receptor AOCs.

Also shown in Table 2-1 are the background data that are used in characterizing the reference scenarios for each group of human receptors at the three AOCs. As can be noted, younger alluvium was identified by the TWG as a background soil type for use in identifying soil COPCs at all three of the human receptor AOCs. Younger alluvium was considered by the TWG to be the likely soil type at these receptor locations prior to mine development. Younger alluvium was also used to characterize the reference soil conditions for the school and offsite residences, while both younger and older alluvium were used to characterize the reference soil conditions for the warehouse. Younger alluvium was also used to characterize indoor dust for the school and offsite residences. Younger alluvium was used as the source term for evaluating airborne dusts in the reference scenario analyses for all three AOCs with human receptors. Detailed descriptions of the methods used to characterize COPC exposures for the reference scenario are provided in Section 2.2.4.

2.1.2 Constituents of Potential Concern

Constituents of potential concern (COPCs) are those constituents occurring in environmental media that exhibit the potential for causing adverse health effects. The COPCs, including radionuclides, for each area of concern have been identified primarily using two processes: 1) examining the results of field and indoor sampling, and 2) screening air emissions data. Field sampling in support of the HHERA characterized metals, lanthanide metals, and radionuclides in soils at the three areas of concern listed above and at six background locations (Tetra Tech 2000a). Indoor carpet dust samples collected at Mountain Pass Elementary School (DHS, 2000) were also analyzed for the same three groups of constituents (see Appendices II.1 and II.2). A larger group of constituents was either measured or calculated to estimate air emissions from the mine and mill facilities; the methods used to identify airborne COPCs are described below and in the workplan (see Appendix C.1 in Appendix I)(ENVIRON 2000a).

For soils, the analytical data were assembled by area of concern (AOC) and depth interval. Samples collected from the top inch of soils at the school were assumed to be the likeliest for school children to contact; thus, these samples were used to identify constituents of potential concern. Soil samples were collected from a six-inch interval at the other two AOCs and at the background locations. Based on the laboratory analyses of these soil samples, a preliminary list of analytes was developed that included chemical and radiological constituents detected in one or more samples at each location (see Appendices II.1and II.2).

Metals and radionuclides of potential concern for the baseline scenario were identified by comparing measured concentrations to naturally occurring (background) concentrations. In accordance with Cal EPA (1997) guidance, comparisons were conducted with the statistical comparison tool, the Wilcoxon Rank Sum (WRS) test. The process used to identify COPCs in soil consisted of three steps:

- Identify a health-protective background data set for soil types in the vicinity of each AOC; the background datasets identified by the TWG are shown in Table 2-1.
- Compare concentrations measured at each AOC to the selected background concentrations using the WRS test.
- Identify metals, lanthanide metals, actinide metals, or radionuclides as COPCs if they are found to be elevated over background based on the WRS test.

In addition, constituents with insufficient data to conduct statistical comparisons with naturally occurring concentrations were selected as COPCs. This process also included the identification of COPCs if background or site characterization data consist of greater than 50 percent nondetected values. The results of the comparison process are provided in detail in Appendix II.3.

The COPCs identified as a result of the comparison of constituent concentrations measured in soil at each AOC and at the relevant background location are shown in Table 2-2. Between 6 to 17 metals, 13 of the lanthanide metals, and 2 actinide metals (uranium and thorium) were identified as COPCs at the human receptor AOCs. The radionuclides were assumed to be in secular equilibrium (see Table 2-3), so the entire decay chains of uranium-238, uranium-235, and thorium-232 were also assumed to be COPCs at each of the AOCs where any member of each decay chain was found to be elevated relative to background concentrations. These radiological and non-radiological COPCs were used to characterize soils for the baseline scenario. To ensure that risks estimated for the reference scenario could be compared directly to the baseline scenario, the same set of COPCs in soil was identified for the reference scenario (see Table 2-4). The procedures used to identify COPCs for the future expansion scenario are described below.

For indoor carpet dust, all of the constituents detected in the indoor carpet dust samples were identified as constituents of potential concern for the baseline scenario. This selection procedure was used because no background samples of indoor carpet dust were collected, and the limited number of carpet dust samples was insufficient to use in comparisons with background soil samples. The result is that for the baseline scenario the COPCs in indoor carpet dust consist of up to 14 metals, 10 lanthanide metals, and the 2 actinide metals. As with soils, the radioactive forms of uranium and thorium and their respective daughter products (i.e., the entire decay chain) were also identified as COPCs (see Table 2-2). The same set of COPCs was used to characterize the reference scenario for indoor carpet dust as was identified for the baseline scenario (Table 2-4). The procedures used to identify COPCs for indoor carpet dust in the future expansion scenario are described below

In contrast to the procedures used to identify COPCs in soil and indoor carpet dust, airborne COPCs were identified using a potency-weighted emissions screening process because of the large number of constituents either measured or estimated to be emitted from mining facilities (ENVIRON 2000a). The screening consisted of a scoring process for all constituents emitted from point and areal (fugitive) sources at the mine and mill site. Scores were based on the emissions and toxicity of each carcinogen and noncarcinogen released to the atmosphere under baseline conditions at the mine and mill site. For certain cases, the potential for exposures via multiple exposure pathways was also used in the scoring process. Scores were used to independently rank carcinogenic and noncarcinogenic constituents. Those constituents representing 99 percent of the relative risk for all constituents were identified as candidate COPCs. In addition, ethylbenzene and xylenes were added at the request of the California Department of Toxic Substances Control (DTSC). Radon was not identified as a COPC because it was not detected in either the school or offsite residences (Tetra Tech 2000a). The TWG reviewed and commented on the proposed ranking process. A final set of COPCs was identified and approved by the TWG on 8 March 2000 (ENVIRON 2000a). The scoring process is provided in the workplan (Appendix C.1in Appendix I). The approved list of COPCs in air at the mine and mill site is shown in Table 2-2.

Future expansion activities were also assumed to potentially result in airborne particulates being deposited on soils. The metals identified as COPCs in air were therefore assumed to be COPCs potentially impacting soils in the future. The entire set of future soil COPCs therefore consisted of the constituents identified as COPCs for the baseline scenario, supplemented with the constituents assumed to be deposited onto soils from airborne particulates released during future expansion activities. These COPCs identified for future incremental increases in soil are shown on Table 2-2.

The COPCs for future indoor carpet dust were also based on the same type of evaluation used to identify future soil COPCs. The COPCs were a combination of those identified for the baseline conditions (i.e., detected in indoor carpet dust samples) and those associated with airborne particulates potentially depositing on soils in the future. This latter assumption was based on the fact that outdoor soils are likely to be a significant source of indoor carpet dust. The COPCs for indoor carpet dust for the future expansion scenario are shown in Table 2-2.

2.1.3 Potentially Exposed Human Receptors

USEPA guidance (1989a) recommends characterizing risks to populations on or near a release site because these receptors may have the greatest potential for exposure to chemicals of potential concern. This includes identifying subpopulations that may be at increased risk from chemical exposures due to increased sensitivity or behavior patterns that may result in high exposure. Subpopulations of particular concern include infants and children, who are more likely to contact soil. Receptor groups at or near the Mountain Pass mine and mill site have been identified using these guidelines in a weight-of-evidence approach. The criteria used in this procedure include whether receptors are: 1) located onsite, 2) potentially sensitive individuals, such as children, 3) chronically exposed (i.e., long-term exposure), and 4) potentially exposed to constituents by one or more routes of exposure (see Table 2-5). As shown in Table 2-6 (and Appendix C.2 in Appendix I), each of these criteria was considered in identifying receptors near the mine and mill site that may have relatively high levels of exposure. The result is that the following three groups of receptors were used as indicators of whether potential constituent exposures under the baseline and future scenarios are of potential concern:

- Schoolchildren at Mountain Pass Elementary School (ages 5-12);

- Offsite residents: CHP and Caltrans employees and families residing near the mine and mill site; and
- Day visitors: typified as employees of companies transporting materials to and from the mine and mill site.

One exception to the above selection process involves onsite workers. The health and safety of onsite workers are regulated by the mining safety and health administration (MSHA) and the California occupational safety and health administration (OSHA). Thus, exposures and risk analyses are not estimated for this group of potential receptors.

2.1.4 Potentially Complete Exposure Pathways

An exposure pathway is complete when there is a location at which chemical uptake by a human receptor may occur. The conceptual site model (CSM) shown in Figure 2-2 identifies the potentially complete exposure pathways for human receptors for the baseline, reference, and future proposed mine expansion scenarios. The CSM for the mine and mill site was developed based on the review of available data reports, including the 1996 draft Environmental Impact Report; a tour of the mine and mill site; a description of mining and mill operations by Molycorp staff, review of the proposed mine expansion project (Molycorp 1999); and discussions with the TWG. The assumptions used in developing the CSMs are key to understanding the potentially complete exposure pathways selected for evaluation. The primary assumption used to determine potentially complete exposure pathways for the baseline and future expansion scenarios is that the mine and mill are operating at full capacity. In contrast, for the reference scenario, it is assumed that exposures are those that could occur in the absence of mine activities.

Chemicals and radionuclides released to the environment during past mining operations may have been transported to human receptor locations. For the baseline scenario, receptors could thereby be directly exposed to the COPCs identified at each AOC. Exposure may occur by a number of different routes, including incidental soil ingestion, direct dermal contact with soil, incidental ingestion of indoor carpet dust, direct dermal contact with indoor carpet dust, and direct irradiation from soils and indoor carpet dust. Also, since the mine and mill site is assumed to be operating at full capacity for the baseline scenario, inhalation of airborne constituents is identified as a complete exposure pathway for those constituents transported from mine and mill facilities. No surface water exposure was evaluated because visitors to the mine and mill site were assumed to have no opportunity to contact onsite ponds and offsite surface water is typically ephemeral. Also, the radon exposure pathway was considered incomplete because radon was not detected in nearby residences or in the school (Tetra Tech 2000a).

At the mine and mill site, a key mine expansion issue for human receptors is the release of chemicals and radionuclides with airborne dusts caused by removal and storage of overburden and tailings. Other expansion activities, such as construction of a new tailings pond, new haul roads, new evaporation ponds, and movement of the flotation plant are also likely to result in the release and airborne transport of COPCs to receptor locations. These transport pathways could result in the inhalation of airborne constituents as part of the future expansion scenario. Furthermore, since receptors could potentially contact particulates that are deposited on soils during future expansion activities, several exposure pathways associated with these particulates are evaluated in the HHRA, including incidental soil ingestion, direct dermal contact with soil, incidental ingestion of indoor carpet dust, direct dermal contact with indoor carpet dust, and direct irradiation from soils and indoor carpet dust.

The CSM (Figure 2-2) shows the potentially complete exposure pathways identified for each group of receptors. Exposures are evaluated for:

- Schoolchildren, including those who may be exposed to COPCs at more than one location (i.e., at school and at nearby residences)

- Offsite residents assumed to be exposed to chemicals and radionuclides as three different age groups, including a young child (1-4 years), a school-age child (5-12 years), and an older child or adult (more than 12-years of age).

- Day visitors, assumed to visit the mine and mill site on a regular basis.

For comparison purposes, the same set of exposure pathways is assumed for the reference, baseline, and future exposure scenarios. The key assumptions used to define the potentially complete exposure pathways are described briefly on Figure 2-2.

Designation of an exposure pathway as complete indicates that human exposure is possible but does not necessarily mean that exposure will occur nor that exposure will occur at the levels estimated in this report. When any one of the factors is missing in a pathway, it is considered to be incomplete. Incomplete exposure pathways do not pose health hazards and were not evaluated in this risk assessment.

The exposure analysis for groundwater at the mine and mill site is presented as a separate set of evaluations (in Appendix V). Near the mine site the groundwater exposure pathway is currently incomplete because residents and school children are supplied with bottled water and potable water pumped from groundwater in Shadow Valley and Ivanpah Valley. However, because there is no control over potential future use of groundwater outside of the mine boundaries, groundwater exposures are evaluated on the basis of measurements of COPCs in groundwater near the southern boundary of the mine and mill site. In accordance with TWG comments, this set of hypothetical exposures is reported separately (see Section 2.8 and Appendix V) and not summed with risks from other exposure pathways for receptors near the mine and mill site.

2.2 EXPOSURE ASSESSMENT

Chemical exposure is a result of the intake or uptake of a chemical from the environment. This section of the report describes the methods used to quantitatively evaluate potential receptor exposures to COPCs.

USEPA-derived exposure algorithms were used to estimate the chemical intakes for each route of exposure evaluated in the HHRA. Chemical intake is expressed as milligrams per kilogram per day (mg/kg/day). The equation below presents the general methodology for calculating chemical intake (I) (USEPA 1989a). Pathway-specific variations of this equation are used to calculate intakes of COPCs. The equations for the pathways evaluated in the HHRA are presented in Table 2-7.

$$I = \frac{C \times CR \times ET \times EF \times ED}{BW \times AT}$$

where

I = Intake: the amount of chemical consumed, inhaled, or contacted per unit body weight per day (mg/kg/day)

C = Constituent concentration; for example, milligrams per kilogram [mg/kg] for soil

CR = Contact rate: the amount of contaminated medium contacted per unit of time or event and may be the ingestion rate, inhalation rate, or dermal contact rate (for example, milligrams per day [mg/day] for the ingestion rate of soil)

ET = Exposure time: the daily time period that an individual is exposed to an environmental medium (for example, the number of hours per day [hr/day] that an individual inhales airborne dust)

EF = Exposure frequency: how often the exposure occurs (days per year [days/year])

ED = Exposure duration: the number of years that a receptor comes in contact with the contaminated medium (years)

BW= Body weight: the average body weight of the receptor over the exposure period (kilogram [kg])

AT = Averaging time: the period over which exposure is averaged (days); for carcinogens, the averaging time is 25,550 days based on a lifetime exposure of 70 years (average life expectancy), and for noncarcinogens, the averaging time is equal to the exposure duration multiplied by the number of days in a year (365 days).

A similar set of calculations is used to evaluate exposures to radiological constituents of concern. However, exposures or intakes, without division by the body weight and averaging time, are generally multiplied by the route-specific slope factors to directly determine carcinogenic risk probabilities (USEPA 1989a). The risk estimation equations for the radiological assessment are provided in Table 2-8.

Parameters used for evaluating exposure of identified receptors have been reviewed and approved by the Technical Work Group. The set selected for use in quantifying exposures for receptors at the mine and mill site is presented in detail in Table 2-9. A key component of this set of exposure parameters is the approach used to evaluate exposures of the offsite residents. Specifically, residents are assumed to consist of three age groups: ages 1-4 years, 5-12 years, and greater than 12 years to adult. This approach allows for the evaluation of the relative contributions of different sources of exposures for a school child (ages 5-12 years).

Since the exposure duration of Mountain Pass residents is assumed to be only 15 years, exposures were adjusted according to the approximate time that each age group may reside near the mine & mill site. As shown in Table 2-9, the exposure duration (5 years) for school children was based on site-specific information. Exposure durations for the young child and adult were assumed to be two and 8 years, respectively. The exposure duration for day visitors (6.6 years) was based U.S. EPA guidance on the typical length of employment at one job.

2.2.1 Soil and Indoor Carpet Dust Exposures

The exposure assessment also accounts for exposures to soil and indoor carpet dust by school children and offsite residents. Based on an examination of regulatory guidance and supporting references (USEPA 1994c; Stanek and Calabrese 1993), it was determined that approximately 50 percent of ingested soils is from outdoor sources and 50 percent is from indoor sources (see Appendix F.5 in Appendix I and Appendix IV.1). Consequently, the HHRA evaluates incidental soil ingestion by assuming that half of a school child’s or resident’s soil exposure occurs indoors (i.e., to indoor carpet dust) and half occurs outdoors (i.e., with soil).

However, since a school child spends time both at school and at home during the school year, exposures to outdoor soil and indoor carpet dust were further subdivided on the basis of the time spent at school and at home. This time-weighting also accounted for children spending 180 days per year in school and the remainder of the year at home. A similar process was also used to estimate indoor and outdoor exposures for the non-school age offsite residents. Thus, using estimates of time spent at home and away from home, the following assumptions were used in evaluating residential exposures to outdoor soil or indoor carpet dust. The detailed analyses are presented in Appendix F.5 (of Appendix I) and Appendix IV.1.

	Percent Contact for Each Residential Age Group		
Exposure Point	**Young Child**	**School Child[1]**	**Older Child/ Adult**
Indoor Dust			
Home	100	75	65
Away	NA	25	35
Outdoor Soil			
Home	100	86	100
Away	NA	14	NA

[1] Considers time spent at home and away from home during the school year and during vacations.
NA= not applicable

To ensure that a consistent approach was used for evaluating each group of receptors, it was also assumed that dermal exposures to outdoor soil and indoor carpet dust would occur at the same time that incidental ingestion of soil and carpet dust is assumed to occur.

2.2.2 Bioaccessibility of Lanthanide Metals, Arsenic, and Lead

Another factor that was used in estimating exposures for potentially exposed receptors is the bioavailability or bioaccessibility of a constituent of concern. Bioaccessibility is the amount of an administered dose that is available to cross the gastrointestinal wall (i.e., available for uptake into an organism). For the HHRA, exposures to lanthanide metals, arsenic, and lead were adjusted based on *in vitro* bioaccessibility tests conducted by Dr. John Drexler (University of Colorado). The bioaccessibility studies by Dr. Drexler consisted of a physiologically based extraction test that mimics gastrointestinal conditions, including stomach pH, mixing, and emptying rates (Ruby et al., 1993 1996). Using soils collected at several areas of concern and indoor carpet dust, Dr. Drexler measured concentrations of lanthanide metals, arsenic, and lead in extraction solutions. The metals detected in the extraction solutions are considered bioaccessible. The results of the studies are provided in the workplan (Appendix C.3 in Appendix I). The proportion of the total concentration that was soluble under conditions mimicking the gastrointestinal tract was used to estimate bioaccessibility. Since bioaccessibility is expressed as a proportion or percentage of the total administered dose, the following bioaccessibility factors were used in estimating uptake of these three metals from incidentally ingested soil and indoor carpet dust.

Constituent	Bioaccessibility Factors
Lanthanide metals	6%
Arsenic	28%
Lead	56%

2.2.3 Dermal Absorption

Dermal absorption (ABS) fractions for evaluating the dermal contact pathways were obtained from Cal EPA 1994a) guidance. These fractions are provided in Appendix IV.1.

2.2.4 Exposure Point Concentrations

Generally, the concentration of a chemical in an environmental medium exhibits spatial variability. Furthermore, receptors may move within an area where COPCs have been detected. Therefore, it is important to estimate the concentration of a COPC in a manner consistent with the location and route of potential human exposure. This estimate of chemical concentration is known as the exposure point concentration (EPC).

Exposure point concentrations (EPCs) for soil and indoor dust exposures are based on available analytical data, to the extent possible. Exposure point concentrations for the inhalation pathways evaluated for the baseline and future expansion scenarios are based on the results of air dispersion modeling. The methods used to estimate EPCs for the baseline, reference, and future expansion scenarios are described in the following sections of the report. The EPCs are provided in Appendix IV.2.

2.2.4.1 Soil

Exposure point concentrations for soil-related exposure pathways in the baseline scenario are based on the results of chemical analyses from soil samples collected at each AOC. At the school these samples were collected in the top inch of soils, whereas samples collected elsewhere were taken from the top six-inches of soil. EPCs were selected according to USEPA (1992e) guidance, as the lesser of two values: 1) the upper 95th confidence limit (UCL_{95}) on the mean concentration or 2) the maximum detected concentration. The formula used to calculate the UCL_{95} depends on the type of distribution that the data fit. Following USEPA guidance (USEPA 1992b), the Student-t formula was used to calculate the UCL_{95} for normally distributed data and the Land formula (Gilbert 1987) was used to determine the UCL_{95} for lognormally distributed data (USEPA 1992b). For nondetected results, the concentration values were replaced with one half of the practical quantitation limit (PQL) for normally distributed data (USEPA 1992e, DTSC 1992) and the PQL divided by the square root of 2 (DTSC 1992) for lognormally distributed data. The EPCs used to estimate exposures to soil are provided in Appendix IV.2.

Exposure point concentrations for soil in the future expansion scenario are based on the results of modeling the deposition of airborne particulates, that are assumed to be incremental increases over baseline concentrations (see Appendices F.8 and F.9 in Appendix I). Exposures and risks were estimated for the modeled incremental concentrations and these risks were summed with the baseline risks to estimate the overall future risks associated with exposures to COPCs in soil. The deposition modeling was conducted in conjunction with the airborne dispersion modeling and is described in Section 2.2.4.3.

Exposure point concentrations for reference (background) soils were calculated using the same approach used to calculate EPCs for the baseline scenario. Specifically, exposure point concentrations for soils in the reference scenario were based on the lesser of either the UCL_{95} or maximum concentration of each COPC. As indicated previously, COPC concentrations in younger alluvium were used to evaluate the reference scenario for all three groups of receptors and COPC concentrations in older alluvium were used for additional comparison purposes for the day visitor.

2.2.4.2 Indoor Carpet Dust

Exposure point concentrations for indoor carpet dust were estimated for the baseline, reference, and future expansion scenarios. The EPCs for the baseline scenario are based on the results of constituent analyses for indoor carpet dust samples collected at the school. For the school, EPCs are based on the average concentration of each constituent measured in samples collected from carpet in two rooms (i.e., the cafeteria/multi-purpose “great room” and the main classroom) where children spend approximately 95 percent their time spent indoors at the school (see Appendix F.5 in Appendix I). No measurements of constituent concentrations in indoor carpet dust at Mountain Pass residences were obtained. Thus, for the Mountain Pass residences the ratios determined by comparing constituent concentrations in indoor carpet dust and outdoor soils at the school were used to predict concentrations in indoor carpet dust relative to outdoor soils at the Mountain Pass residences (see Appendix F.5 in Appendix I). The EPCs used for estimating exposures to indoor carpet dust at the school and the offsite residences are provided in Appendix IV.2.

Exposure point concentrations for indoor carpet dust in the future expansion scenario were based on the results of the deposition modeling for future airborne particulates. Future indoor carpet dust EPCs were based on the sum of baseline EPCs plus incremental increases calculated using the fractional increases calculated for COPC concentrations in outdoor soils as a result of future particulate deposition. The deposition modeling was conducted in conjunction with the airborne dispersion modeling and is described in Sections 2.2.4.3 and 2.2.4.4.

No background indoor carpet dust samples were collected. Thus, for the reference scenario it was assumed that the EPCs for indoor carpet dust exposures are identical to the reference soil EPCs. To ensure that risks estimated for the reference scenario could be compared directly to the two scenarios of interest, reference exposures were calculated for the same set of COPCs identified for the baseline scenario.

2.2.4.3 Air

Airborne chemical concentrations had not been measured at the mining facilities prior to the estimation of EPCs for this HHRA. Therefore, EPCs used in estimating potential exposures to airborne COPCs for the baseline and future scenarios were dependent on air dispersion conducted for the mine and mill site. Air dispersion modeling was conducted by ENVIRON (2000b) for the baseline and future expansion scenarios. A brief summary of the sources, meteorological data, receptor locations, and the air dispersion modeling procedures are provided in this section of the HHRA.

Airborne chemical concentrations were predicted for the most part using the USEPA's Industrial Source Complex Short Term (ISCST3) air dispersion model (ENVIRON 2000b). The ISCST3 model was run using USEPA default settings, including the assumption of rural conditions and that receptors are located at elevations similar to or lower than emission sources (i.e., the FLAT model option). Because of the short time frame of blasting operations, annual average air concentrations for blast-related releases were estimated using a Gaussian puff dispersion model (ENVIRON 2000b).

The air dispersion modeling for the baseline and future expansion scenarios was based on estimates of chemical emissions from mining facilities operating at full capacity. Environmental Risk Management, Inc. (ERMI 1999) estimated facility emissions from the following sources:

<u>Point Sources</u>

- Mineral Recovery Plants, including the Cerium 96 Plant, Separation Plant, and Specialty Plant
- Mill/Flotation Plant

<u>Fugitive Sources</u>

Mobile source activities, including vehicle traffic

<u>Area Sources</u>

Operational sources, stockpiles, and ponds

Emissions were based on source-specific test data and emission factors published by the USEPA (1995), California Air Resources Board (1999), the Ventura County Air Pollution Control District (1995), and the Mojave Desert Air Quality Management District (CARB 1991a, b).

In addition, for the future mine expansion scenario ERMI estimated emissions from existing sources that may be modified, including the mine pit, four ponds (P-1, P-16, P-17, P-18), the overburden stockpiles, and roads. Emissions were also calculated for new sources, including the proposed construction activities and the proposed East Tailings Storage Facility (ERMI 1999). Of the 22 different future emission scenarios that have been described for the 30-year expansion plan, 15 scenarios were used in the air dispersion modeling, including one phase of operation for the west overburden stockpile, two phases of operation for the pit, two phases of expansion for the north overburden stockpile, three phases of construction for the northwest evaporation ponds, and six phases of operation for the east tailings storage facility. Modeling also incorporated changes in emissions due to closure of four ponds and relocation of the crusher mill and flotation plant.

Using the emission estimates, airborne dispersion modeling was used to predict annual average airborne constituent concentrations for receptors evaluated for the baseline and future mine expansion scenario. The air dispersion modeling was based on recent surface meteorological data collected at the mine and mill site and upper air meteorological data collected at the Mercury Desert Rock Airport, NV.

Airborne constituent concentrations were predicted for the three receptor populations identified in this HHRA, i.e., school children, offsite residents, and day visitors (Figure 2-2). Two locations were modeled for the residential population: (1) one location in the north portion of the residential area and (2) one location in the east portion of the residential area. However, since the predicted constituent concentrations were very similar, only the concentrations predicted for the north location were used in estimating exposures for the offsite resident. Also, for the future expansion scenario, exposures were estimated using the constituent concentrations averaged over the 30 years of the proposed project plan. The 30-year average constituent concentrations, as well as the concentrations predicted for each year are provided in Appendix II.2.

To provide an estimate of risks potentially posed from airborne constituents for the reference scenario, airborne dust concentrations were estimated using a two-step process. First, an airborne dust (PM10) concentration was estimated from monitoring data collected in a nearby desert area (i.e., Clark County, Nevada) (ENVIRON 2001) (Appendix F.10 in Appendix I). The TWG determined that the annual average airborne dust concentration (13.4 $\mu g/m^3$) measured at this desert environment was similar to that monitored near the fenceline of the mine and mill site. Second, it was assumed that constituent concentrations in airborne dust were comparable to the same fraction measured in background (i.e., young alluvium) soils. The results of this two-step calculation process were used as the EPCs for the airborne dust exposure pathway for the reference scenario. The EPCs are provided in Appendix IV.2.

2.2.4.4 Future Deposition

Constituent concentrations that may occur due to the deposition of airborne (dust) particulates on soil were also estimated for the future expansion scenario. Estimates of particulate deposition potentially occurring during the future expansion scenario were made using the conservative methodology found in the *Air Toxics "Hot Spots" Program Risk Assessment Guidelines* (CAPCOA 1993). The average soil concentrations for each constituent are a function of the airborne constituent concentration associated with total suspended particulates (TSP), particulate deposition rate, constituent specific half-lives in soil, accumulation period, soil bulk density, and mixing depth. Constituent concentrations in soil were estimated by assuming that deposition would occur for a 30-year period and that deposited particulates would mix with only the top centimeter of soil.

Constituent concentrations in indoor carpet dust were also adjusted to account for changes potentially occurring as a result of future particulate deposition. It was assumed that the relationship between constituent concentrations in indoor dust and outdoor soil will be the same in the future as for the baseline scenario. This relationship (described in detail in Appendices F.8 and F.9 in Appendix I) was therefore used to estimate the future concentration of each constituent in indoor dust. The constituent concentrations used for estimating exposures to indoor carpet dust are provided in Appendix IV.2.

2.2.4.5 Summary

The types of data used to estimate exposure point concentrations for each receptor and each exposure scenario are summarized in Table 2-10. Exposures calculated for each group of receptors for the baseline, future, and reference exposure scenarios are presented in Appendices IV.3 and IV.4.

2.3 TOXICITY ASSESSMENT

The toxicity assessment evaluates the potential for chemical and radiological constituents to cause either cancer or noncancer adverse health effects. The assessment consists primarily of tabulations of critical toxicity values for the chemicals of potential concern (COPCs). For this assessment, the USEPA (1997a, 1999a) and Cal EPA (1994b, 1999, 2000) are the primary sources of toxicity values for the COPCs. A conservative set of toxicity values was selected for evaluation of the health risks potentially associated with exposure to the constituents of concern (see *Task 4* in Appendix I). The sources used to identify each toxicity value are provided in Tables 2-11 to 2-15.

For carcinogenic chemicals, the slope factor (SF) is used to determine an upper-bound probability that an individual will develop cancer as a result of a lifetime of exposure. Route-specific SFs are used to evaluate the oral and inhalation exposure pathways, and oral SFs are used to assess dermal exposures. The oral and inhalation SFs used in the HHRA are provided in Tables 2-11 and 2-12.

SFs for radionuclides are typically based on best estimate values and have been developed for each of the three major exposure pathways — inhalation, ingestion, and direct irradiation. The radionuclide SFs used in the HHRA are shown in Table 2-13. Also, to account for all of the daughter products of a given decay chain considered to be in secular equilibrium, prior to calculating radiological risks the slope factors shown in Table 2-13 were summed for all the of the longer lived daughter products in that decay chain.

The toxicity information considered in the assessment of noncarcinogenic effects is the reference dose (RfD). Separate RfDs were used to evaluate oral and inhalation exposures, and oral RfDs were used to assess dermal exposures. The oral and inhalation RfDs proposed for the evaluation of chronic exposures in the human health risk assessment (HHRA) are provided in Tables 2-14 and 2-15. These RfDs are supplemented by reference concentrations (RfCs) and reference exposure levels (RELs) that the USEPA and Cal EPA have determined, respectively, to be representative of acceptable levels of lifetime exposure.

An issue of particular concern for the Mountain Pass Mine risk assessment is the absence of verified toxicity values from Cal EPA or USEPA for the majority of lanthanide metals. Therefore, for this HHRA, toxicity values were developed by Toxicology Excellence for Risk Assessment (TERA 1999)(see Appendix C.4 in Appendix I). Health risks from all of the lanthanide metals were evaluated conservatively by using the oral RfD for lanthanum chloride and the inhalation RfC for ceric oxide (see Tables 2-14 and 2-15). The chronic oral effects of lanthanum chloride was reported as a decrease body weight (in rats), increases in certain types of red blood cells and liver enzyme levels, and cellular changes and/or erosion and swelling in the stomach (TERA 1999, 2001). Chronic inhalation effects of cerium oxide were reported as cell changes in lung tissue (in rats), in addition to deposition of pigment in the nasal cavity, bronchial tubes, and trachea. Inhalation of gadolinium reportedly causes increased mortality and pneumonia (in mice) and decreased lung elasticity (in guinea pigs) (TERA 1999, 2001).

Recently, the USEPA (2000b) has released an issue paper describing a provisional reference dose for one of the lanthanide metals, specifically dysprosium (see Appendix IV.8). The provisional oral RfD for dysprosium (0.2 mg/kg/day) differs by a factor of approximately 40 from that developed by TERA for evaluating the oral route of exposures to lanthanide metals. The potential effects of this difference on the risks estimated in this HHRA are examined in the uncertainty analysis.

It should be noted that the toxicity data used to evaluate lanthanide metal exposures in this HHERA are based on chronic (long-term) exposures. The toxic effects from acute (short-term) exposures are not evaluated, but a toxicity value used to evaluate acute effects is likely to be larger than that used to evaluate chronic, long-term exposure to lanthanide metals. This determination is based on the fact that a smaller uncertainty factor would be applied to the available toxicity studies in order to characterize acute health effects. Assuming that short-term exposures do not differ from those estimated for chronic, long-term exposures to lanthanide metals, the risks estimated with a higher toxicity value could be substantially less (e.g., by a factor of 10) than those estimated in this report.

An alternative set of risk estimates was also determined for several other constituents (cadmium, manganese, mercury, nickel, and vanadium). This set of risk analyses was conducted at the request of the TWG, using alternate toxicity values developed by the Agency for Toxic Substances and Disease Registry (ATSDR). The results of these analyses are presented in Appendix IV.7 and are discussed briefly in Section 2.9.

2.3.1 Assessment of Lead

The health effects associated with lead are typically estimated on the basis of blood-lead concentrations. DTSC (1992, 2000) has developed a mathematical model to estimate blood-lead levels on the basis of total lead uptake from exposures via diet, drinking water, air, and soil. This model was used for assessing potential health effects associated with exposures to lead. Three types of potential lead exposures were evaluated that are specific to the mine and mill site: (1) incidental ingestion of soil and indoor carpet dust, (2) lead bioaccessibility, and (3) inhalation of airborne lead. The concentration of lead in drinking water was assumed to be comparable to the federal MCL of 15 μg/L. Predicted levels of exposure are provided in Appendix IV.5. The relationship of the overall blood-lead levels to potential health risk is described in Section 2.4.

Based on recommendations by DTSC (M. Schum, pers. comm.), noncarcinogenic health effects potentially posed by exposure to lead are also supplemented by an evaluation of potential carcinogenic risks. Potential carcinogenic risks are estimated using the SF developed by Cal EPA (1999) and the risk estimates presented both with and without the contribution from exposures to lead. The potential cancer risks from lead exposure are provided in Appendix IV.7 and are described briefly in the uncertainty analysis (Section 2.9).

2.3.2 Toxicity Profiles

A set of brief toxicity profiles has been prepared for COPCs contributing significantly to the risk assessment and provided in Appendix IV.6. These profiles provide information of interest for the general public and include information about biological effects of each COPC, including acute and chronic health effects. References are included that identify documents where more detailed toxicity descriptions can be found.

2.4 RISK ESTIMATION

The final step in the human health risk assessment is the characterization of potential risks associated with human exposure to site-specific chemicals. The risk characterization integrates the exposure and toxicity assessments to produce quantitative estimates of potential health risks associated with exposure to the COPCs. Because of fundamental differences in the critical toxicity values, the estimates of potential excess carcinogenic risks and noncarcinogenic health effects are developed separately.

2.4.1 Estimation of Carcinogenic Risks

Risks associated with exposure to COPCs classified as carcinogens are estimated as the incremental probability that an individual will develop cancer over a lifetime as a direct result of an exposure (USEPA 1989a). Carcinogenic risks for non-radioactive constituents are estimated by multiplying chemical intake by the chemical-specific SF:

Chemical-Specific Cancer Risk =
Intake (mg/kg/day) x SF (mg/kg/day)$^{-1}$

The estimated risk is expressed as a unitless probability.

Radiological risk probabilities are calculated following a similar formula as follows:

$$R = E \times RU$$

where

R = estimated individual excess lifetime cancer risk
E = exposure or intake for each COPC (pCi)
RU = route and COPC specific risk (risk/pCi)

Risks are estimated for individual routes of chemical and radiological exposure and across exposure pathways, as identified in the conceptual site model (Figure 2-2). As agreed by the TWG, risks for chemical and radiological constituents are summed separately for all pertinent exposure pathways.

Estimates of risks relative to levels of concern to the USEPA and DTSC are examined. Risk probabilities are compared to the generally acceptable risk range specified by the USEPA. According to the revised National Contingency Plan (NCP) (USEPA 1990), carcinogenic risks from exposures to COPCs are considered to be unacceptable at a level greater than 1×10^{-4}, whereas risks smaller than 1×10^{-6} are considered to be of minimal concern. Action may not be necessary in the risk range of 10^{-6} to 10^{-4} (i.e., the target risk range). This is supported in the directive “Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions” (USEPA 1991b), which indicates action is generally not warranted at a site when the cumulative carcinogenic risk for current and future land use is less than 10^{-4} or the cumulative noncarcinogenic Hazard Index (HI) is less than 1. In general, a potential excess individual lifetime cancer risk of 1 x 10^{-6} is used as a “point of departure” by the USEPA and DTSC when determining whether risk management actions may need to be considered to be protective of human health. As a risk management policy, the Cal EPA generally accepts remedial actions based on a risk of 1 x 10^{-5}, for the Air Toxics “Hot Spots” Information and Assessment Act and the Safe Drinking Water and Toxic Enforcement Act (Proposition 65). Each of these potentially acceptable levels of risk helps put the numerical risk estimates into perspective.

2.4.2 Noncarcinogenic Hazards

For COPCs that are not classified as carcinogens and for those carcinogens known to cause adverse health effects other than cancer, the potential for exposure to result in noncarcinogenic effects is evaluated by comparing the intake with an RfD and presented as a ratio termed the “hazard quotient” (HQ):

$$\textit{Hazard Quotient} = \frac{\textit{Intake (mg/kg/day)}}{\textit{RfD (mg/kg/day)}}$$

Analogous to carcinogenic risks, HQs are summed across exposure pathways identified in the CSMs to develop Hazard Index (HI) values. HQs and HIs are not risk probabilities, but currently are accepted by the USEPA and DTSC as quantitative levels of risk for noncarcinogens or the noncarcinogenic endpoints of carcinogens. An HQ or HI value less than 1 indicates that action is not warranted. In cases where the summation of HIs exceed 1 and the COPCs do not cause the same health effect, HIs are presented separately for COPCs potentially causing the same type of health effect (i.e., same toxic endpoint) (USEPA, 1989a).

2.5 RISK ESTIMATES FOR DAY VISITOR

Day visitors are assumed to be adults who may visit the mine and mill site on a regular basis. For this HHRA, the day visitor was typified as an employee of a company transporting materials to or from the mine and mill site. The day visitor is assumed to visit the mine site one hour per day for a period of 6.6 years, the average length of employment (USEPA 1997b). The day visitor is assumed to incidentally ingest soil, have direct dermal contact with soil, be exposed to direct radiation from radionuclides in the soil, and inhale airborne constituents in the vicinity of the onsite warehouses. Cancer risk estimates and noncancer hazard indices were calculated for the day visitor for the baseline and future expansion scenarios. A reference scenario based on naturally occurring (background) constituent concentrations is also presented for comparison purposes. Risk estimates for potential exposures to non-radioactive constituents (Appendix IV.3) are presented separately from those for radiological constituents (Appendix IV.4). The potential for adverse health effects resulting from exposures to lead is also described.

2.5.1 Baseline Risk Estimates

2.5.1.1 Risk Estimates for Non-radioactive Constituents

Cancer risk estimates were calculated for the day visitor exposed to non-radioactive COPCs under the baseline exposure scenario. Figure 2-3 and Table 2-16 shows that the overall cancer risk estimate for the day visitor is approximately 1 x 10^{-9}. This risk estimate is three orders of magnitude less than the USEPA and DTSC “point of departure” of 1 x 10^{-6} and substantially less than the acceptable risk range of 10^{-6} to 10^{-4}. Potentially carcinogenic COPCs were not identified in soils that the day visitor may contact. Thus, all of the estimated risks result from the inhalation of airborne constituents. However, since the risk probability estimated for the reference scenario (4 x 10^{-9} as shown in Table 2-17) is similar to that estimated for the baseline scenario, the baseline risk estimates are essentially comparable to background conditions.

Noncancer hazard quotients (HQs) and hazard indices (HIs) were also calculated for the day visitor. All of the HQs were determined to be less than 0.025, regardless of the COPC (Table 2-18 and Figure 2-4). Similarly, the HIs for each exposure pathway were estimated to be 0.03 or less. The summation of HIs for all exposure pathways was also estimated to be approximately 0.04. The HIs estimated for potential day visitor exposures to younger and older alluvium reference soils, respectively summed with reference air exposures, are approximately 0.01 and 0.02 (see Tables 2-19 and 2-20) for all health effects. Although these HIs are less than that estimated for the baseline scenario, all three sets of HIs are less than 1.

In accordance with USEPA (1989a) guidance, the HQs calculated for each COPC are also summed depending on the type of health effect that each COPC may cause at an exposure level comparable to its reference dose, i.e., at a HQ of 1. Potential health effects for each COPC were based on the critical effects defined by the USEPA and Cal EPA, as listed in Tables 2-21 and 2-22). Table 2-21 shows that the COPCs at the mine and mill site could be associated primarily with potential health effects on the respiratory system. The HQs and HIs calculated for this type of health effect are presented separately for the day visitor (as shown in Tables 2-18 to 2-20) and later for the other groups of receptors for which noncancer health effects were evaluated. As shown in Tables 2-18 to 2-20, effects to other types of systems in the body, such as the circulatory system, are also grouped together for ease of reporting. As shown in Table 2-18 and Figure 2-4, the HIs calculated for the day visitor for the two groups of potential COPC health effects under the baseline scenario are respectively, 0.3 and 0.008. The HIs calculated for the reference scenarios (Tables 2-19 and 2-20) are less than those estimated for the baseline scenario, but all of these HIs are substantially less than 1.

Lead concentrations in blood were predicted for the day visitor using the lead spreadsheet model developed by DTSC (2000). As shown in Table 2-23 (and Appendix IV.5) predicted blood-lead concentrations for the baseline scenario range from 2.5 to 3.5μg/dL. None of the predicted blood-lead levels exceed the action level of 10 μg/dL.

2.5.1.2 Risk Estimates for Radioactive Constituents

Radiological risks were calculated for the day visitor exposed to the radioactive constituents uranium-238, uranium-235, thorium-232 and their respective daughter (decay) products. Figure 2-5 and Table 2-25 show that the baseline radiological risks estimated for these radioactive constituents is nearly 1×10^{-5}. The risk from direct exposure to outdoor soil is more than 99 percent of the total risk. Also, as shown in Figure 2-5, the baseline radiological risk estimate exceeds the risks from exposures to radionuclides in reference soils (5×10^{-6}) by a factor of approximately two, although both estimates are within the acceptable risk range.

2.5.2 Future Risk Estimates

2.5.2.1 Risk Estimates for Non-Radioactive Constituents

Cancer risk estimates were calculated for the day visitor exposed to non-radioactive COPCs as a result of the future expansion scenario. Figure 2-3 and Table 2-25 show that the overall cancer risk estimate for the day visitor is approximately 4×10^{-8}. This risk estimate is less than the USEPA and DTSC "point of departure" of 1×10^{-6}. The risk probability estimated for the reference scenario (4×10^{-9}) is less than that estimated for the future scenario (Figure 2-4), although all are substantially less than the "point of departure."

Noncancer hazard quotients (HQs) and hazard indices (HIs) were also calculated for the future expansion scenario as shown in Figure 2-4 and Table 2-26. All of the HQs were determined to be less than 0.035, regardless of the COPC. Similarly, the summation of HIs for all exposure pathways was also estimated to be 0.04. Table 2-27 shows that the HIs calculated for COPCs grouped by health effect are 0.03 and 0.01, respectively, for potential effects to the respiratory and other organ systems. In comparison, HIs calculated for the reference scenario were calculated to be approximately 0.003 and 0.01 for potential effects to the respiratory and other organ systems when exposures are assumed only for the COPCs in younger alluvium soils. HIs for exposures to COPCs in older alluvium soils are somewhat higher (0.003 and 0.02 for respiratory and other health effects, respectively). However, all of the HIs estimated for future and reference exposures for day visitors are substantially less than 1.

Lead concentrations in blood were predicted for the future day visitor using the lead spreadsheet model developed by DTSC (2000). Table 2-23 (and Appendix IV.5) shows that predicted blood-lead concentrations for the future expansion scenario range from 2.2 to 3.5 μg/dL. None of the predicted blood-lead levels exceed the action level of 10 μg/dL.

2.5.2.2 Risk Estimates for Radioactive Constituents

Radiological risks associated with the future activities at the mine and mill site to a visitor were evaluated for the same pathways evaluated for the baseline scenario. Figure 2-5 shows that the future radiological risks are estimated to be essentially the same as those estimated for the baseline scenario, approximately 1 x 10^{-5}. The risk from direct exposure to outdoor soil is more than 99 percent of the total risk (see Table 2-24). This risk estimate is approximately twice that predicted for exposures to radionuclides in reference soils. Nonetheless, all of these risk estimates are within the acceptable risk range.

2.5.3 Comparison of Future and Baseline Risk Estimates

Risks estimated for the day visitor for the future expansion scenario slightly exceed those for the baseline scenario. Cancer and noncancer risks for the non-radioactive constituents were estimated to increase by factors of approximately 20 and 1.1, respectively. However, the risk estimates for both scenarios are considered to be of minimal concern, because cancer risk estimates for the non-radioactive constituents are substantially less than 1 x 10^{-6} and noncancer hazard indices are substantially less than 1. As indicated above, the radiological risks estimated for the baseline and future expansion scenarios are essentially identical (1 x 10^{-5}), although both estimates exceed levels estimated for the reference scenario. Nevertheless, based on these calculations, health risks for the day visitor for the baseline and future mine expansion scenarios are in the generally acceptable range.

2.6 RISK ESTIMATES FOR MOUNTAIN PASS ELEMENTARY SCHOOL CHILDREN

Schoolchildren are assumed to be children between the ages of five and 12 years old who attend Mountain Pass Elementary School (MPES) and do not reside in Mountain Pass. School children who also reside in Mountain Pass are addressed in Section 2.7. For this HHRA, schoolchildren are assumed to attend MPES for 6.75 hours per day during five school years. The school child is assumed to contact soil and indoor carpet dust on a daily basis, resulting in incidental ingestion, direct dermal contact with soil and indoor carpet dust, and direct exposure to radiation from radionuclides in the soil and dust. A school child is also assumed to inhale airborne constituents transported from the mine and mill site. Cancer risk estimates and noncancer hazard indices were calculated for school children potentially exposed to constituents of potential concern for the baseline and future expansion scenarios. A reference scenario based on naturally occurring (background) constituent concentrations is also presented for comparison purposes. Risk estimates for potential exposures to non-radioactive constituents (Appendix IV.3) are presented separately from those for radiological constituents (Appendix IV.4). The potential for adverse health effects resulting from exposures to lead is also described.

2.6.1 Baseline Risk Estimates

2.6.1.1 Risk Estimates for Non-radioactive Constituents

Cancer risk estimates were calculated for schoolchildren exposed to non-radioactive COPCs under the baseline exposure scenario. Table 2-27 shows that the overall cancer risk estimate for a school child is approximately 1.4 x 10^{-7}. This risk estimate is less than the USEPA acceptable risk range of 10^{-6} to 10^{-4}. Figure 2-3 and Table 2-28 show that the risks estimated for the baseline scenario are comparable to those estimated for the reference scenario (2 x 10^{-7}). Thus, it appears that carcinogenic risks estimated for the baseline scenario for school children at MPES do not differ from reference (background) conditions.

Table 2-29 shows that the noncancer hazard quotients (HQs) and hazard indices (HIs) calculated for the MPES schoolchild are less than 0.1, regardless of the COPC. The summation of HIs for all exposure pathways is approximately 0.2, although the HIs grouped by potential health effects are less. As shown in Figure 2-6, the HIs for potential effects to the respiratory and other systems were estimated to be 0.05 and 0.14, respectively. The noncancer HQs estimated for the reference scenario (Table 2-30 and Figure 2-6) are less than those estimated for the baseline scenario, with none exceeding 0.04. However, all of the HIs for the baseline and reference scenario are less than 1.

Lead concentrations in blood were predicted for schoolchildren using the lead spreadsheet model developed by DTSC (2000). As shown in Table 2-24, predicted blood-lead concentrations for the baseline scenario range from 4.4 to 6.0 μg/dL. None of the predicted blood-lead levels exceed the action level of 10 μg/dL. The lead spreadsheet calculations supporting the blood-lead estimates are provided in Appendix IV.5.

2.6.1.2 Risk Estimates for Radioactive Constituents

The sum of the radiological risks estimated for schoolchildren for the baseline scenario is 1.6 x 10^{-5}, as shown in Table 2-24 and Figure 2-5. Interestingly, this risk estimate is essentially comparable to the risk estimated for similar exposures to reference conditions (1.9 x 10^{-5}) since rounding to one significant digit (as per USEPA 1989a guidance) results in risk estimates of 2 x 10^{-5} for both exposure scenarios. The risk from direct exposure to outdoor soil and indoor carpet dust is more than 99 percent of the total risk for both scenarios. As shown in Table 2-24, incidental ingestion of outdoor soil and indoor carpet dust and inhalation of airborne dusts are relatively minor sources of risks for both scenarios, with estimated risks less than 2 x 10^{-7}. Both of the risks estimated for the baseline and reference scenarios are within the USEPA acceptable risk range.

2.6.2 Future Risk Estimates

2.6.2.1 Risk Estimates for Non-Radioactive Constituents

Cancer risk estimates were calculated for schoolchildren exposed to non-radioactive COPCs as a result of the future expansion scenario. Table 2-31 shows that the overall cancer risk estimate for a school child is approximately 1.7 x 10^{-7}. The risks estimated for the future expansion scenario also differ only minimally (12 percent) from those estimated for the reference scenario (see Table 2-28 and Figure 2-3). Both of these risk estimates are less than the USEPA and DTSC "point of departure" of 1 x 10^{-6}.

Noncancer HQs calculated for the future expansion scenario are less than 0.1, regardless of the COPC (Table 2-32). The summation of HIs for all exposure pathways is approximately 0.2, with the HIs for potential effects to the respiratory and other systems estimated to be 0.06 and 0.16, respectively. As shown in Figure 2-6, these HIs slightly exceed those calculated for the reference scenario, although none exceed 1.

Lead concentrations in blood were predicted for schoolchildren using the lead spreadsheet model developed by DTSC (2000). Table 2-23 shows that the predicted blood-lead concentrations for the future expansion scenario range from 4.4 to 6.1 μg/dL. None of the predicted blood-lead levels exceed the action level of 10 μg/dL. The lead spreadsheet calculations supporting the blood-lead estimates are provided in Appendix IV.5.

2.6.2.2 Risk Estimates for Radioactive Constituents

Radiological risks estimated for schoolchildren for the future expansion scenario are essentially identical to those estimated for the baseline scenario (Table 2-24), with both sets of risks estimated to be 1.6 x 10^{-5}. As for the baseline scenario, the future risks from direct exposure to outdoor soil and indoor carpet dust are more than 99 percent of the total risk. Also, risks estimated for the future expansion scenario are essentially the same as those estimated for the reference scenario. All are within the acceptable risk range.

2.6.3 Comparison of Future and Baseline Risk Estimates

The cancer and radiological risks estimated for the school child for the baseline and future exposure scenarios are identical. Both sets of risk estimates are also essentially comparable to the risks that could potentially occur from exposure to naturally occurring concentrations of metals, lanthanide metals, and radionuclides. Figures 2-3 and 2-5 show that all of the cancer and radiological risk estimates for school children are within the acceptable risk range. Additionally, under the baseline and future expansion scenarios, the calculated HIs indicate that adverse health effects are not likely to occur as a result of schoolchild exposures to non-radioactive constituents although both sets of HIs exceed those estimated for the reference scenario (Figure 2-6).

2.7 RISK ESTIMATES FOR OFFSITE RESIDENTS

Offsite residents are assumed to be the California Highway Patrol (CHP) and California Department of Transportation (Caltrans) employees and their families who reside near the mine and mill site. Residents are assumed to consist of three age groups: a young child, a school-age child, and an older child or adult. This approach allows for the evaluation of the relative contributions of different sources of exposures to the risks estimated for a residential school child. All three groups of offsite residents are assumed to be exposed to constituents of potential concern by incidentally ingesting soil and indoor carpet dust, having direct dermal contact with soil and indoor carpet dust, being exposed to direct radiation from radionuclides in the soil and dust, and inhaling airborne constituents. Cancer risk estimates were calculated for offsite residents, based on a combined exposure period of 15 years. Noncancer hazard indices (HIs) were calculated separately for each age group. Cancer risk estimates and noncancer HIs were calculated for the baseline and future expansion scenarios. A reference scenario based on naturally occurring (background) constituent concentrations is also presented for comparison purposes. Risk estimates for potential exposures to non-radioactive constituents (Appendix IV.3) are presented separately from those for radiological constituents (Appendix IV.4). The potential for adverse health effects resulting from exposures to lead is also described.

2.7.1 Baseline Risk Estimates

2.7.1.1 Risk Estimates for Non-radioactive Constituents

Cancer risks estimated for the offsite resident are approximately 2 x 10^{-6}. Figure 2-3 and Table 2-34 show that approximately half (1 x10^{-6}) of the risks estimated for the offsite resident are from contacting arsenic in indoor carpet dust. In comparison, the risks estimated for the offsite resident for the reference scenario are almost entirely due to exposure arsenic in indoor carpet dust, and are approximately 1 x10^{-6} (Table 2-35).

This similarity in risk estimates indicates that offsite residential exposures to constituents in indoor carpet dust are likely to be similar to naturally occurring background conditions. As noted in Section 2.1.2, all constituents detected in indoor carpet dust were identified as COPCs because a statistical comparison to background was not possible due to the limited number of carpet dust samples. However, as shown below, the exposure point concentrations used to assess potential risks for offsite residents for all three exposure scenarios are highly similar, differing by no more than 2 mg/kg. Arsenic concentrations in outdoor soil at the offsite residences also are similar to concentrations in indoor carpet dust, with an outdoor UCL_{95} concentration of 6.8 mg/kg.

Offsite Resident Exposure Scenario	Exposure Point Concentrations for Arsenic in Indoor Carpet Dust (mg/kg)
Baseline	5.9
Future	6.0
Reference	7.6

Since the risk estimates for baseline and reference exposures to arsenic in indoor carpet dust are nearly identical, the inhalation exposure pathway is the sole source of risks exceeding background. The other half is from inhalation of a number of constituents (such as benzene, chromium VI [representing all chromium emissions], and crotonaldehyde) that individually do not represent risks greater than 7 x 10^{-7}. Nonetheless, all of these risk estimates are within the USEPA acceptable risk range of 10^{-6} to 10^{-4} and less than the criterion (1 x 10^{-5}) used in risk management for the Air Toxics "Hot Spots" Information and Assessment Act and the Safe Drinking Water and Toxic Enforcement Act (Proposition 65).

Noncancer hazard quotients (HQs) and hazard indices (HIs) were calculated for each age group of the offsite residents. The results shown in Tables 2-35 to 2-40 and Figures 2-7 to 2-9 indicate the following:

- HQs calculated for the majority of COPCs are less than 0.1.

- None of the HIs calculated for the soil or indoor carpet dust exposure pathways exceed 1.

- Inhalation of lanthanide metals results in HQs greater than 1 for the young child (2.5) and school age child (1.1), based on the conservative toxicity value used to evaluate health effects from inhalation of lanthanide metals. The chronic health effects from inhalation of cerium oxide are reported as cell changes in lung tissues (TERA 2001). A discussion of the health protective nature of the lanthanide toxicity values is provided in Section 2.9.

- HIs grouped according to health effect exceed 1 for effects to the respiratory system for the young child (HI=3.8), the school-age child (HI=1.6), and the adult (HI=1.2). The HIs for other health effects do not exceed 1.

- Other than the lanthanide metals, the primary COPCs contributing to HIs exceeding 1 are acrolein and chlorine, although exposure to either COPC alone results in a HI less than 0.7. Exposure to these COPCs occurs only by the inhalation pathway for the baseline scenario, when it assumed that the mine and mill site is operating at full capacity.

- HIs estimated for the baseline scenario are two or more times greater than those estimated for the reference scenario; none of the HIs estimated for the reference scenario exceed 1.

Thus, as part of the baseline scenario, inhalation of a limited group of COPCs results in HIs exceeding 1 and also contributes to noncancer risk estimates greater than those estimated for reference conditions.

Lead concentrations in blood were predicted for each group of offsite residents using the lead spreadsheet model developed by DTSC (2000). As shown in Table 2-23 (and Appendix IV.5), predicted blood-lead concentrations for the baseline scenario range from 2.5 to 6.8 μg/dL. None of the predicted blood-lead levels exceed the action level of 10 μg/dL.

2.7.1.2 Risk Estimates for Radioactive Constituents

Radiological risks estimated for the offsite residents as part of the baseline scenario are 1.5 x 10^{-4}. As shown in Figure 2-5 and Table 2-24, direct exposure to outdoor soil and indoor carpet dust is the primary source of these risks. Risks estimated for incidental ingestion or inhalation of radionuclides are less than 4 x 10^{-7}. Although the overall risk estimated for offsite residents is at the upper bound of the acceptable risk range (1 x 10^{-4}), this risk estimate is less than that estimated for the reference scenario (3 x 10^{-4}). This situation occurs partially because risk estimates for indoor carpet dust are the results of exposures to all constituents, including radionuclides, detected in carpet dust. Statistical comparisons to background concentrations were not conducted because of the limited number of indoor carpet dust samples (see Section 2.1.2). Consequently, radiological exposures for baseline and reference conditions are similar; for example, the EPCs for U238+d are 0.84 and 1.07 pCi/g for baseline and reference conditions, respectively. Based on this consideration and that baseline radiological risk estimates for exposures to outdoor soil are less than those for the reference condition, it appears that baseline radiological risks estimated for offsite residents do not exceed those estimated for naturally occurring conditions.

2.7.2 Future Risk Estimates

2.7.2.1 Risk Estimates for Non-Radioactive Constituents

Cancer risks estimated for the offsite residents for the future expansion scenario are approximately 2.4 x 10^{-6}. As for the baseline scenario, these risk estimates are also divided almost equally between exposure to indoor carpet dust and inhalation of airborne constituents (see Figure 2-3). Furthermore, as shown in Table 2-41, exposure to arsenic is the primary source of risks estimated for indoor carpet dust exposures, as it was for the baseline and reference scenarios. Since risks from exposure to arsenic in indoor carpet dust are essentially the same for the reference and future expansion scenarios, the inhalation pathway is the primary route of exposure resulting in risks greater than background. Nonetheless, all of these risk estimates are within the USEPA acceptable risk range of 10^{-6} to 10^{-4}.

Noncancer hazard quotients (HQs) and hazard indices (HIs) were also calculated for each age group of the offsite residents exposed to COPCs as part of the future proposed mine expansion. Figures 2-7 to 2-9 show that the noncancer HQs and HIs calculated for the three offsite residential age groups for the future expansion scenario have the same pattern as that observed for the baseline scenario. Tables 2-42 through 2-44 show that HQs are less than 1 except for those estimated for the inhalation of lanthanide metals. HQs of 2.8, 1.3, and 0.87 were calculated for lanthanide inhalation by the young child, school-age child, and adult, respectively. A discussion of the health protective nature of the lanthanide toxicity values is provided in Section 2.9.

The HQs estimated for inhalation of lanthanide metals also contribute to HIs for the three groups of offsite residents that exceed 1 for health effects to the respiratory system. In the case of the offsite adult resident, HQs for chlorine (0.16) and (0.18) also contribute to an HI exceeding 1 for respiratory health effects. Thus, noncancer HIs exceed 1 for the offsite residents primarily because of the inhalation of a limited set of constituents.

Lead concentrations in blood were predicted for offsite residents using the lead spreadsheet model developed by DTSC (2000). Table 2-23 (and Appendix IV.5) shows that the predicted blood-lead concentrations for the future expansion scenario range from 2.5 to 7.2 μg/dL. None of the predicted blood-lead levels exceed the action level of 10 μg/dL.

2.7.2.2 Risk Estimates for Radioactive Constituents

The radiological risks estimated for offsite residents for the future expansion scenario are 1.5 x 10^{-4} (Table 2-24). This risk estimate is essentially identical to that estimated for the baseline scenario (1.5×10^{-4}). As shown in Figure 2-5, direct exposure to outdoor soils and indoor carpet dust is the primary source of the estimated risks, as was the case for the baseline scenario. Both the baseline and future risk estimates are within the acceptable risk range and less than those estimated for the reference scenario (3×10^{-4}). Thus, radiological risks estimated for offsite residents for the future expansion scenario do not exceed those estimated for naturally occurring conditions.

2.7.3 Comparison of Future and Baseline Risk Estimates

As shown in Figure 2-3, cancer risks estimated for the offsite resident exposure to non-radioactive constituents for the future scenario are approximately 20 percent higher than those estimated for the baseline scenario (2.4×10^{-6} compared to 2.0×10^{-6}). These results are consistent with the radiological risks estimated for the baseline and future expansion scenario, which are essentially identical (1.5×10^{-4}), as shown in Figure 2-5. Similarly, although HIs for each of the three age groups were estimated to be higher for the future scenario than the baseline scenario, the increases are relatively minor. For example, the HIs for respiratory effects estimated for the young child are 3.8 and 4.0 for the baseline and future scenarios, respectively. Thus, the future and baseline risk estimates for carcinogenic, radiological, and noncancer health effects to offsite residents essentially do not differ.

2.8 GROUNDWATER RISK EVALUATION

Based on direction from the TWG, the risks estimated for hypothetical groundwater use are reported as a separate set of evaluations (in Appendix V). This was considered reasonable since groundwater near the mine and mill site is currently not used. Nearby residents and school children are supplied with bottled water and potable water is obtained from groundwater in the Shadow and Ivanpah Valleys. However, as there are no restrictions governing the use of groundwater in the area of the mine and mill site, the TWG determined that people could choose to reside near the mine and mill site and hypothetically use local groundwater in the future.

Assuming hypothetical use of groundwater monitored near the southern mine boundary, exposures to COPCs were evaluated for groundwater ingestion, dermal contact with groundwater during showering, and inhalation of radon potentially emitted from groundwater during showering. Cancer, radiological, and noncancer risk estimates for these potential exposure routes were calculated using the same approach used in evaluating exposures to COPCs in soil and air. The parameters used in these analyses are provided in Appendix V. The risk calculations indicate that hypothetical groundwater use could result in health risks of concern for several groundwater constituents, including seven metals (arsenic, barium, boron, manganese, mercury, nickel, and strontium); the lanthanide metals; one inorganic (nitrate); and one actinide metal (uranium). As indicated above, the risks estimated for hypothetical groundwater use were not summed with those from soil or air exposures because groundwater is currently not used near the mine and mill site and there is no reasonable expectation of groundwater use in the near future. Thus, the detailed analyses of hypothetical groundwater use are provided in Appendix V.

2.9 UNCERTAINTY ANALYSIS

The cancer risk probabilities, radiological risks, and noncancer hazard indices were calculated for the human receptors at the mine and mill site using a number of assumed values. As a result, there are uncertainties associated with the final risk estimates.

The USEPA in their *Guiding Principles for Monte Carlo Analysis* (USEPA, 1997c) defines uncertainty as “a lack of knowledge about specific factors, parameters or models.” A lack of knowledge or information exists in each of the four main components of any human health risk assessment: 1) identification of constituents of potential concern (COPCs); 2) exposure assessment; 3) toxicity assessment; and 4) risk characterization. The site-specific sources of uncertainty in each of these four components of the HHRA are identified below. Each is characterized in terms of (1) whether assumed values could have resulted in the over- or under-estimation of risk and (2) whether any source of uncertainty could significantly impact the risk estimates. Those identified as potentially significant sources of uncertainty are discussed in detail in Sections 2.91 to 2.9.3.

Sources of Uncertainty in the Identification of COPCs

For the identification of COPCs, two possible sources of uncertainty were considered: a lack of background data for constituents detected in indoor carpet dust, and the lack of a consistent set of COPCs in soil for both the baseline and future expansion scenario. Since potential impacts to soil-related exposures by all COPCs were addressed as part of the risk-screening process, those constituents identified as COPCs for the air dispersion modeling were those with the highest relative risk. Thus, this data gap (i.e., lack of deposition modeling for all COPCs in soil) is likely to have had only a minor effect on underestimating risks. In contrast, the lack of background data for indoor carpet dust was considered a potentially significant source of uncertainty in the identification of constituents of potential concern. This source of uncertainty is discussed in more detail in Section 2.9.1.

Sources of Uncertainty in the Exposure Assessment

The potential sources of uncertainty for the exposure assessment include:

- Use of weight-of-evidence approach to identify receptors of concern;
- Limited information available for estimating the time spent contacting indoor carpet dust;
- Lack of information on constituent concentrations in residential carpet dust;
- Use of the highest measured radionuclide concentration as the exposure point concentration for each decay chain;
- Limited measurements of lanthanide bioaccessibility;
- Lack of information on the exposure duration for each individual potentially residing at Mountain Pass;
- Limited information on the accuracy of the air modeling; and
- Limited information on reference air conditions.

The potential significance of each of these sources of uncertainty was considered. The five items at the start of the above list were not considered to be significant sources of uncertainty, although each issue was addressed using health protective assumptions to ensure that exposures and associated risks were not underestimated (i.e., exposures may have been overestimated). Further, the procedures and values used to characterize each of these exposure factors were reviewed and approved by the TWG. Thus, although individual activities may vary from those assumed in this HHRA, receptors were selected using criteria designed to identify groups of individuals who could have the greatest potential for exposure. Similarly, in addressing the limited information on exposures to indoor carpet dust, it was assumed that time spent indoors would result in exposure to indoor carpet dust, although such exposure is likely to vary according to the daily activities of exposed individuals.

Likewise, the process used to estimate constituent concentrations in residential carpet dust was intended to be health protective to ensure that this data gap did not result in the underestimation of risks. Instead of assuming that indoor and outdoor exposures are similar at the offsite residences, it was assumed that indoor exposures could be higher because constituent concentrations observed in indoor carpet dust at the school were higher than those measured in outdoor soil.

An analogous procedure was also used in evaluating exposures to radionuclides, in that exposures were based on the highest concentration measured for any member of a decay chain. Given the random nature of radioactive decay and the variability of radiation detection and measurement methods, the actual concentration of the chain would be closer to that of the average measured concentration of the chain's constituents. Consequently, the approach used in this HHRA consistently overestimates the exposures to radionuclides and the associated carcinogenic risks.

Also, although laboratory analyses were conducted on lanthanide bioaccessibility under conditions mimicking both stomach and intestinal conditions, bioaccessibility in this HHRA was based on only the results observed for stomach conditions. This approach, although not validated with *in vivo* experiments, may have resulted in the overestimation of lanthanide bioaccessibility (assuming lanthanide metal absorption occurs in the intestines). Acidic conditions of the *in vitro* tests mimicking the stomach could have resulted in higher levels of bioaccessibility than those for the more neutral conditions typical of the tests of intestinal conditions. To account for the limited information on lanthanide bioaccessibility (i.e., a data gap) and the other factors discussed above that may be sources of uncertainty in this HHRA, the available information was used to develop a health-protective exposure estimate. Overall, the exposure assumptions may have resulted in a small to moderate overestimation of risks.

Thus, only the following three sources of uncertainty were considered to be the most likely to significantly affect the risk estimates.

- Lack of information on the exposure duration for each individual potentially residing at Mountain Pass
- Limited knowledge on the accuracy of the air dispersion modeling
- Limited information on reference air conditions.

Each of these sources of uncertainty in the exposure assessment is discussed in more detail in Section 2.9.2.

Sources of Uncertainty in the Toxicity Assessment

All of the uncertainties in the toxicity assessment involve the selection of toxicity values for use in estimating risks. In general, the toxicity selection process was addressed by following USEPA and DTSC guidance and using a hierarchy of sources starting with the most health-protective toxicity values derived either by the USEPA or Cal EPA. It should be noted that this process could result in a relatively large level of uncertainty because characterization of toxicity values typically includes multiple sets of uncertainty factors. Use of these uncertainty factors ensures that a toxicity value is health protective when only limited amounts of experimental data are available to determine toxic effects in humans. Toxicity values developed by the USEPA may have an "uncertainty spanning an order of magnitude or greater" (USEPA 1989a). Thus, risks may be overestimated to the same extent as the level of uncertainty in the health-protective toxicity values.

At the request of the TWG, risk estimates were based on toxicity data developed for a subset of constituents by the Agency for Toxic Substances and Disease Registry (ATSDR). The risk estimates (provided in Appendix IV.7) based on the ATSDR toxicity values do not differ significantly from those shown in Sections 2.5 to 2.7, therefore, they are not considered further. A similar conclusion was also reached with regard to the evaluation of lead as a potential carcinogen (based on the cancer slope factor developed by the Cal EPA and reported in Appendix IV.7). Thus, the only potentially significant source of uncertainty in the toxicity assessment was the lack of a agency-derived set of toxicity values for the lanthanide metals (e.g., cerium, lanthanum). This source of uncertainty is discussed in more detail in Section 2.9.3.

Sources of Uncertainty in the Risk Characterization

In addition to the uncertainties identified for the three other major components of the HHRA, the risk characterization process also includes uncertainty involving the limited information available on constituent interactions. USEPA (1989a) guidance recognizes that the summation of risks estimated for individual constituents could result in uncertainties about the overall risk estimates. However, this procedure was recommended because there is limited information available on the antagonistic or synergistic effects of exposures to two or more constituents. Thus, although this lack of information on constituent interactions may be a source uncertainty in this HHRA, risks were estimated according to guidance and this source of uncertainty is not examined in more detail.

On the whole, this HHRA was conducted in accordance with USEPA guidance (1989b), such that the assumptions used to characterize risks are likely to overestimate exposure and toxicity. These assumptions were used to ensure that risk estimates are protective. Thus, actual incidence of cancer or other health effects is likely to be lower than those calculated in this HHRA.

2.9.1 Uncertainties in the Identification of COPCs

The primary method used to identify constituents of potential concern in soil was the comparison of concentrations measured in the area of concern with concentrations measured in a reference (background) location. This comparison process was not possible, however, for constituents detected in indoor carpet dust, since limited samples were taken of indoor carpet dust and no background samples were collected. Consequently, all constituents detected in indoor carpet dust were identified as COPCs. As a result of a lack of information on naturally occurring concentrations of these constituents in indoor carpet dust (i.e., a data gap), the risk estimates are likely to consist of a combination of risks from exposure to naturally occurring (background) concentrations in addition to those from concentrations exceeding background. In turn, the risks associated with indoor carpet dust could contribute to an overestimate of risks for the schoolchildren and offsite residents. Nevertheless, this potential source of uncertainty is on the whole relatively minor because risks for reference conditions exceed those for the baseline and future scenarios. For example, as shown in Figure 2-3, cancer risks for the offsite residents were estimated to be approximately 1 x 10^{-6} for both the baseline and future exposure scenario, assuming arsenic concentrations in indoor carpet dust range from 6 to 8 mg/kg. A risk estimate of 1 x 10^{-6} is at the DTSC "point of departure." However, as also shown in Figure 2-3, the risks are similar to those expected if arsenic concentrations in reference indoor carpet dust are assumed to be comparable to those for reference soils (4.8 to 7.9 in younger alluvium). Thus, these results suggest that collection of background data for indoor carpet dust could reduce this source of uncertainty in the risk assessment.

2.9.2 Uncertainties in the Exposure Assessment

Three potentially significant sources of uncertainty were identified for the exposure assessment:

- Lack of information on residential exposure duration
- Limited information on the accuracy of the air dispersion modeling
- Limited information on reference air conditions.

Lack of information on the specific number of years that each resident or student may spend near the mine and mill site is a potentially significant source of uncertainty. As discussed in Section 2.3, it was assumed that residents reside near the mine and mill site for 15 years. The number of years that MPES residents may spend near the mine and mill site is uncertain, although in the past the range has varied from 2 to 15 years (O. Schweseaker pers. comm). Since cancer risk estimates are based on the cumulative effects of exposure, a short exposure duration would result in a smaller risk probability for an offsite resident. Risk estimates for offsite residents could therefore vary by factors of five to ten. Thus, this potential source of uncertainty should be considered in the evaluation of the risks estimated for the offsite residents.

The limited information on the accuracy of the air dispersion modeling is a potentially significant source of uncertainty in the risk estimates. One of the factors contributing to uncertainty in the results of the air dispersion modeling is the use of one set of data for wind direction and frequency for all receptors. The reasons that this factor contributes to uncertainty in the risk assessment are discussed below in conjunction with the results of the recent air monitoring data collected at the mine and mill site.

Exposure estimates for airborne constituents in the baseline and future expansion scenarios were obtained from air dispersion modeling results (described by ENVIRON 2000b). The use of modeling results is standard practice for estimating the concentration of atmospherically dispersed constituents because air-monitoring data are generally not available, and future conditions can only be estimated by modeling.

The model used to predict the concentrations of airborne constituents for the baseline and future expansion scenarios assumed the existence of a fixed set of site conditions (ENVIRON 2000b). This type of model application is referred to as a deterministic simulation. No uncertainty analyses were conducted as part of the modeling effort. Such analyses would have provided estimates of the variability associated with predicted chemical concentrations as well as information on the sensitivity of the model results to the selected values of individual input parameters. Although one-year's worth of meteorological data is recommended in modeling guidance issued by the U.S. EPA (40 CFR Part 51, Appendix W: *Guideline on Air Quality Models*), as indicated below, this time frame may not be sufficient to account for the spatial differences in meteorological conditions that exist at the site.

Air monitoring that has recently been conducted in the vicinity of the mine and mill site provides measurements of the concentrations of a subset of the constituents included in the risk calculations. These data were collected for periods up to three weeks at four locations in the vicinity of the mine and mill site. This sampling was conducted between August and December 2000 (ENVIRON 2001a), and the results provide a basis of comparison with the concentrations predicted by the model. ENVIRON (2001a), for example, suggests that the modeling results may have overestimated airborne concentrations of lanthanides, barium, lead, and manganese concentrations by factors of 2 to 9 and possibly underestimated airborne concentrations of aluminum and chlorine by factors of 20 to 25,000. The apparent underestimation of chlorine exposures by the air modeling, however, may be due to the influence of nearby exhaust sources, such as trucks at the warehouse or on the freeway, at the monitoring locations (ENVIRON 2001a).

The basis of the assertion that modeling may overestimate exposures is that the wind direction during the monitoring event was similar to that for 1996, the year for the meteorological data selected for use in the air dispersion modeling. As indicated in the table below, 48 percent of the time during the period of the model simulation the wind direction was from the south and southwest (S/SW). The wind direction for the period August through December 1996 in the model simulation was from the S/SW 54 percent of the time, and the wind direction during the recent sampling period (August-December 2000) was from the S/SW 41 percent of the time at the onsite meteorological station.

Monitoring Location	Wind Direction Frequency	
	From the South/SW*	From the North/NE*
1996 modeling data (annual)	48	11
1996 modeling data (Aug-Dec)	54	12
1996 modeling data (Jan-Mar)	47♦	18♦
Onsite Met. Station (Aug-Dec 2000)	41	21
Near School (Location #3) (Aug-Dec 2000)	39	35

* Frequencies estimated from wind roses (ENVIRON 2001a).

♦ Frequencies estimated from the hourly onsite meteorological data set for 1996 (ENVIRON 2000b).

However, the wind direction frequencies presented in the above table also indicate discrepancies between the wind data used in the modeling and the measured values during the monitoring period. The wind direction was from the north and northeast (N/NE) (the direction that would place the majority of the receptors downwind of the primary sources) 11 percent of the time during 1996, but measurements taken at the onsite meteorological station show that 21 percent of the time the wind was from the N/NE during the period of the monitoring. At the Near-School monitoring site (Location #3), 35 percent of the time the wind was from the N/NE direction. Closer examination of the meteorological data set for 1996 also shows the existence of seasonal differences in wind direction. During the period January through March 1996 the frequency of wind from the N/NE was 18 percent versus the annual average of 12 percent. Overall, these comparisons show that there are temporal and spatial differences in the wind conditions between the monitoring period and the modeling period that diminish the significance of direct comparisons between the modeling and monitoring results.

Other differences in the conditions between the monitoring and the modeling periods may exist that were not quantified. These include source location, emission characteristics, and the differences between the averaging times used in the modeling (7 to 24 hours per day) and monitoring (24 hours per day). Overall the results of the air monitoring provide information on the magnitude (approximately 2 to 20,000) of uncertainty that may exist in the simulated concentrations of airborne constituents. However, the presence of multiple source locations, variable emission characteristics in addition to the differences in meteorological conditions rule out the ability to adjust the constituent concentrations used in the risk assessment based on the values measured in the monitoring program. Such an adjustment of the source strength would require making speculative assumptions regarding all parameters that characterize the emission sources.

Limited information on reference (background or ambient) air conditions also contributes to uncertainty in the risk assessment. As described in Section 2.2.4.3, airborne constituent concentrations for the reference scenario are a data gap and were estimated using a combination of airborne dust (PM_{10}) measurements from a nearby desert location and constituent concentrations in younger alluvium sampled near the mine and mill site. The PM_{10} measurement used as the basis for calculating potential airborne metal concentrations for ambient (reference) conditions was obtained from measurements taken in Clark County, Nevada. The sampling location was at the junction of Highways 15 and 161 approximately 40 kilometers from Mountain Pass and, therefore, was considered similar to conditions near the mine and mill site. This was confirmed by the general similarity of the PM_{10} measurements with those monitored near the mine and mill site fenceline.

Two factors suggest, however, that the Clark County PM_{10} may underestimate PM_{10} levels that are representative of reference (ambient) conditions in the absence of the mining facility at Mountain Pass: 1) other monitoring locations in nearby desert areas have higher PM_{10} levels, and 2) other sources of dusts may not be accounted for in the data used to represent reference conditions.

Between 1998 and 2000, PM_{10} measurements in nearby desert locations (San Bernardino, Inyo, Riverside, Imperial, and Clark counties) varied from 13.4 to 117.9 $\mu g/m^3$ (ENVIRON 2001b). Although the higher levels may have been collected in areas exceeding federal and state ambient air quality standards, federal and state standards for these desert areas are 30 and 50 $\mu g/m^3$, respectively. Compliance with these standards could, therefore, result in PM_{10} measurements that are 2 to 4 times higher than the level used in characterizing the reference scenario (ENVIRON 2001b). Based on this consideration, risk estimates for the inhalation of airborne dusts for the reference scenario could therefore be underestimated by factors of 2 to 4.

The underestimation of PM_{10} levels could significantly affect the HIs calculated for the reference scenario, particularly in the case of the young child resident. Assuming that reference conditions are 2 to 4 times higher than used in this report, the overall HIs estimated for the young child could vary from 0.6 to 1.0 for health effects other than respiratory effects. These HIs would be comparable to those estimated for the baseline and future exposure scenarios. Similar increases could be calculated for the respiratory health effects and for the other groups of receptors. Therefore, these results indicate that the difference between reference and baseline or future scenarios could be less than calculated in this HHERA.

Another potential source of uncertainty in the reference scenario is the lack of information on the origin of ambient airborne dusts. As characterized in this HHERA, younger alluvial soils were assumed to be the source of airborne dusts for the reference scenario. However, as shown in Figure 1-5, it is clear that a variety of soil types occur in the vicinity of the mine and mill site. A number of constituents, such as lanthanide metals, occur at higher concentrations in several of these soils (e.g., older alluvium) than in younger alluvium. In addition, other sources, such as traffic along Interstate Highway 15, could influence reference (ambient) conditions. Based on this consideration alone, it appears likely that the risks estimated for the reference scenario are underestimated, although the magnitude of underestimation is not known.

The uncertainties associated with both the air dispersion modeling results and the ambient airborne dust concentrations could be greatly reduced by the adoption of a long-term monitoring program. The monitoring program should include measurements of wind speed and direction at the primary receptor locations as well as the concentrations of airborne COPCs, such as the lanthanide metals.

2.9.3 Uncertainties in the Toxicity Assessment

The toxicologists on the TWG agree that the toxicity values (i.e., reference dose and reference concentration) used to evaluate health effects from lanthanide metal exposures are conservative (i.e., health protective) values. The uncertainty in the toxicity assessment is due primarily to the limited amount of scientific data available on the toxic effects of lanthanide metals in humans and animals. When the available data are not sufficient to support reliable estimates of the levels of exposure to a substance that are likely to be without an appreciable risk of adverse effects, scientists incorporate uncertainty, or "safety" factors in the derivation of toxicity estimates (RfDs and RfCs). These uncertainty factors are intended to compensate for the lack of the necessary data and ensure that the actual toxicity is not underestimated. Both of the toxicity values (reference dose and reference concentration) used to evaluate exposures to lanthanide metals include total safety factors of 3,000. Thus, the toxicity estimates used in the HHRA reflect the lack of adequate toxicological information about the lanthanide. In turn, this uncertainty in the toxicity of lanthanide metals affects the risk estimates because the level eliciting potential health effects in chronically exposed humans is not known.

A wide range of toxicity values for lanthanide metals could have been adopted for the human health risk assessment. For this risk assessment, the most conservative, health protective values were used to determine the potential health effects for on-site visitors, schoolchildren, and local residents exposed to lanthanide metals in soils, indoor carpet dust, and airborne dusts. Three points were considered in evaluating (1) the appropriateness of the lanthanide metal toxicity values used in the human health risk assessment and (2) the magnitude of the uncertainty associated with the predicted human health risks:

1) The approach used to develop the lanthanide metal toxicity values for this HHRA

2) An alternative approach for evaluating toxicity study results

3) The toxicity value recently developed by the USEPA for one of the lanthanide metals

As indicated in Section 2.3, the lanthanide metal toxicity values used in the HHRA were developed by Toxicology Excellence in Risk Assessment (TERA 1999). TERA followed USEPA guidance for developing RfDs and RfCs, including:

- Review of the available scientific literature;

- Identification of a critical health effect and an experimental exposure level at which this critical effect does not occur;

- Application of modifying or uncertainty factors (UFs) to the selected exposure level to account for differences between animals and humans, experiment duration and chronic or long-term exposures, sensitivity of different groups of humans, and strength of the supporting database.

The literature review conducted by TERA identified 33 studies on lanthanide metal toxicity (see Appendix C.4 in Appendix I). All of these studies were considered in determining the toxicity data (i.e., critical studies) that could be used as the basis of the RfDs and RfCs. TERA provided a description of each of the identified studies and concluded that only a limited number of studies could be used in determining the lanthanide metal RfDs or RfCs. As a result, only six RfDs and two RfCs were derived for six of the lanthanide metals (see Appendix C.4 in Appendix I). The studies that were not used were found to lack certain technical elements or data required to meet the rigorous requirements for deriving RfDs and RfCs.

As a result of the data review, the RfD for lanthanum chloride was based on one short-term study in which the critical effect was a decrease in body weight. Similarly, the RfC for ceric oxide was established using one subchronic study with the critical health effect of bronchial lymph node hyperplasia (cell changes in the lung tissue). TERA applied a highly conservative set of uncertainty factors in deriving these RfDs and RfCs because of the limited set of toxicity studies available for the lanthanide metals and because the critical toxicity studies were based on subchronic experiments with lab animals. Specifically, the lanthanum chloride RfD and ceric oxide RfC were each derived using an overall uncertainty factor of 3000, the maximum level used by the USEPA in deriving RfDs or RfCs. TERA concluded that the development of additional toxicity data could increase the confidence in the toxicity values and justify the use of smaller uncertainty factors. Use of smaller uncertainty factors could correspondingly result in increases in the levels of the RfDs or RfCs derived for the lanthanide metals.

Since all of the lanthanide metals were evaluated using the oral RfD for lanthanum chloride and the inhalation RfC for ceric oxide, a change in the uncertainty factors used to derive these toxicity values could modify the outcome of the risk assessment. Changes in the uncertainty factors used to derive the ceric oxide RfC are of particular significance with regard to the HIs calculated for inhalation of airborne lanthanide metals. Even a small increase in the ceric oxide RfC could result in a reduction of the hazard indices calculated for offsite residents, possibly to levels less than a HI of 1, which corresponds to the acceptable level of noncarcinogenic risk. Thus, information that could possibly be obtained from additional lanthanide metal toxicity studies could substantially change the results of this risk assessment.

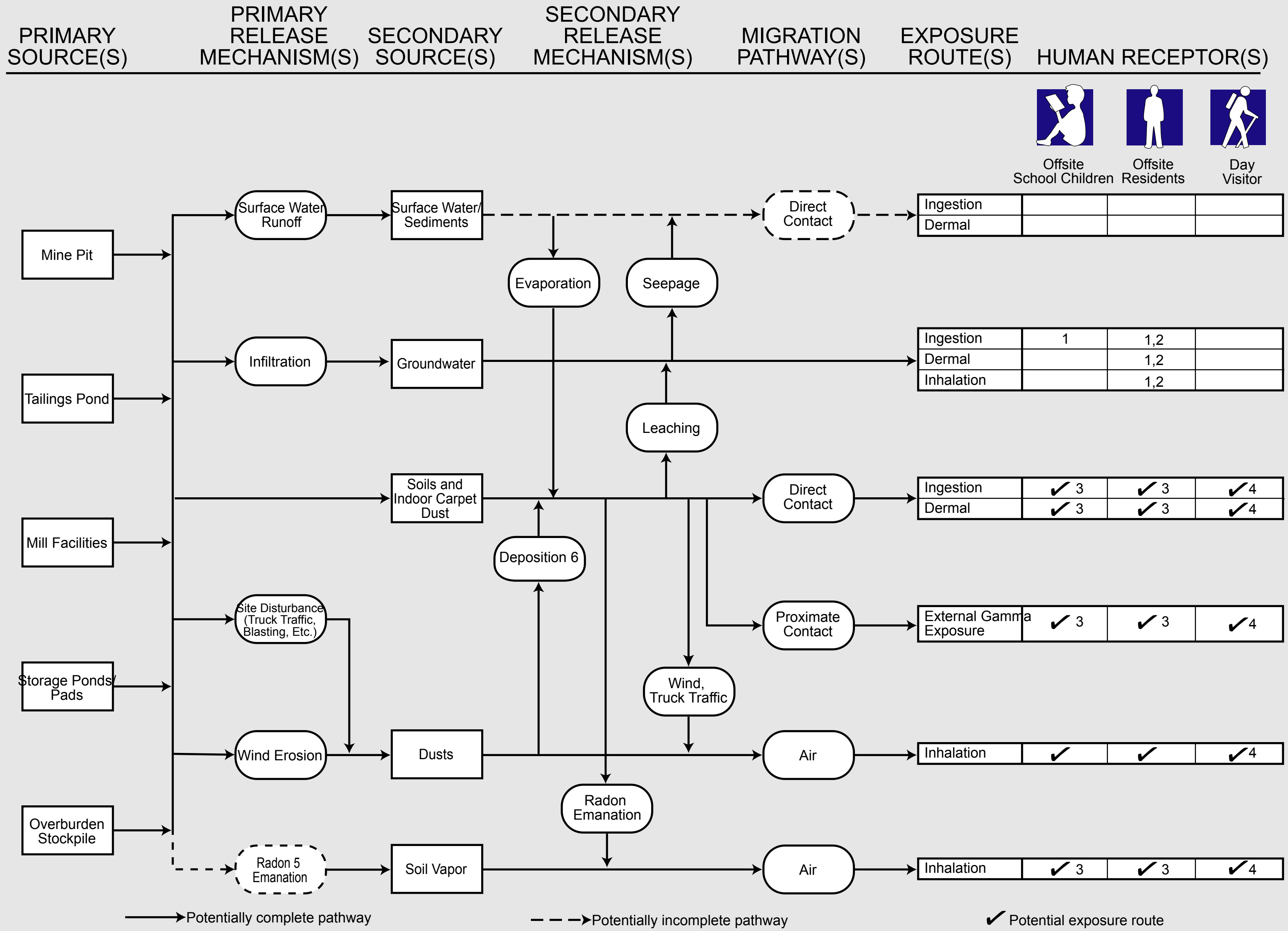
The Cal EPA (2000) approach for deriving inhalation toxicity values provides an indication of the potential level of uncertainty in the toxicity data used in the HHRA. Notably the Cal EPA (2000) approach includes a different method for assigning UFs to toxicity data derived from subchronic experiments conducted for differing periods of time (i.e., different experimental durations). In particular, the Cal EPA has established detailed guidelines for assigning different UFs depending on the duration of the critical subchronic study used as the basis of an RfC. In contrast, the USEPA does not address the issue of study duration and provides only a general range of UFs that could be used in the RfC derivation process. Another difference between the USEPA and Cal EPA RfC derivation process is that the USEPA includes a UF for describing the strength of the database supporting the toxicity analysis, whereas the Cal EPA does not. Rather, the Cal EPA only derives RfCs for those chemicals for which there is a “strong scientific database.” Thus, depending on which UFs are used in the derivation of a surrogate toxicity value, the Cal EPA approach could result in a ceric oxide RfC that is approximately 1.1 or 11 times greater than that derived by TERA. The estimated HIs would be reduced comparably. Regardless, since the strength of the toxicity database for health effects of inhaled lanthanide metals is limited, additional experimental work is necessary to more fully determine the level of uncertainty in the HIs calculated in this report.

Another factor that should be considered in evaluating the HIs calculated in this report is the recent development of an oral RfD for dysprosium by the USEPA (2000b). Since the dysprosium RfD was derived by the USEPA, it is likely that this RfD would have been used, if it had been available at the time when toxicity criteria were being selected for use in this HHRA. Since the dysprosium RfD is approximately 40 times greater than the lanthanum chloride RfD derived by TERA, the noncarcinogenic HIs calculated for the oral and dermal exposure pathways could also differ by this amount. Using the dysprosium RfD would result in HIs less than 0.01 for the oral and dermal exposures to lanthanide metals evaluated in this risk assessment. Thus, this difference in the two oral RfDs indicates the potential level of uncertainty in the noncarcinogenic HIs estimated for these two types of exposures to lanthanide metals.

In some cases, the USEPA suggests that the toxicity of a chemical can be evaluated using a route-to-route extrapolation, i.e., use the toxicity assigned to one route of exposure, such as the oral route, to another route of exposure. However, this procedure was not used for dysprosium. Instead, the USEPA deferred derivation of an inhalation RfC for dysprosium, citing a lack of experimental data for evaluating inhalation of dysprosium and that “the potential for inducing respiratory system (pneumocosis, lung fibrosis) lesions is related to chemical type, physiochemical form, and dose and duration of exposure.” In other words, the USEPA required additional data in order to determine an appropriate toxicity value for inhalation of dysprosium.

Consequently, the TWG has concluded that there are uncertainties in the toxicity assessment that require additional experimental evidence to fully characterize the potential health effects of the lanthanide metals.

Figure 2-1. Receptor locations at Molycorp Mountain Pass Mine.



Notes
1 School and nearby residents use bottled water for drinking water. Fresh water is supplied by Molycorp from ground water wells in Invapah and Shadow valleys.
2 Hypothetical use of ground water at the mine boundary is evaluated as a separate set of analyses. The proposed tailings pond and onsite evaporation ponds will be lined for the expansion alternative; future conditions will assume ground water cleanup.
3 Offsite receptors are assumed to be exposed to soils and indoor carpet dust in offsite locations, either at this school or nearby residences.
4 Onsite worker exposures under baseline conditions and the expansion alternative are assumed to monitored under the mine's industrial hygiene program. Day visitors are more likely to have unprotected soil contact.
5 Radon was not detected in indoor air sampled at the school and the CHP residences.
6 Future expansion activities are assumed to cause incremential increases in deposited constituents.

Figure 2-2
Mountain Pass Mine and Mill Site Conceptual Site Model for Human Receptors.

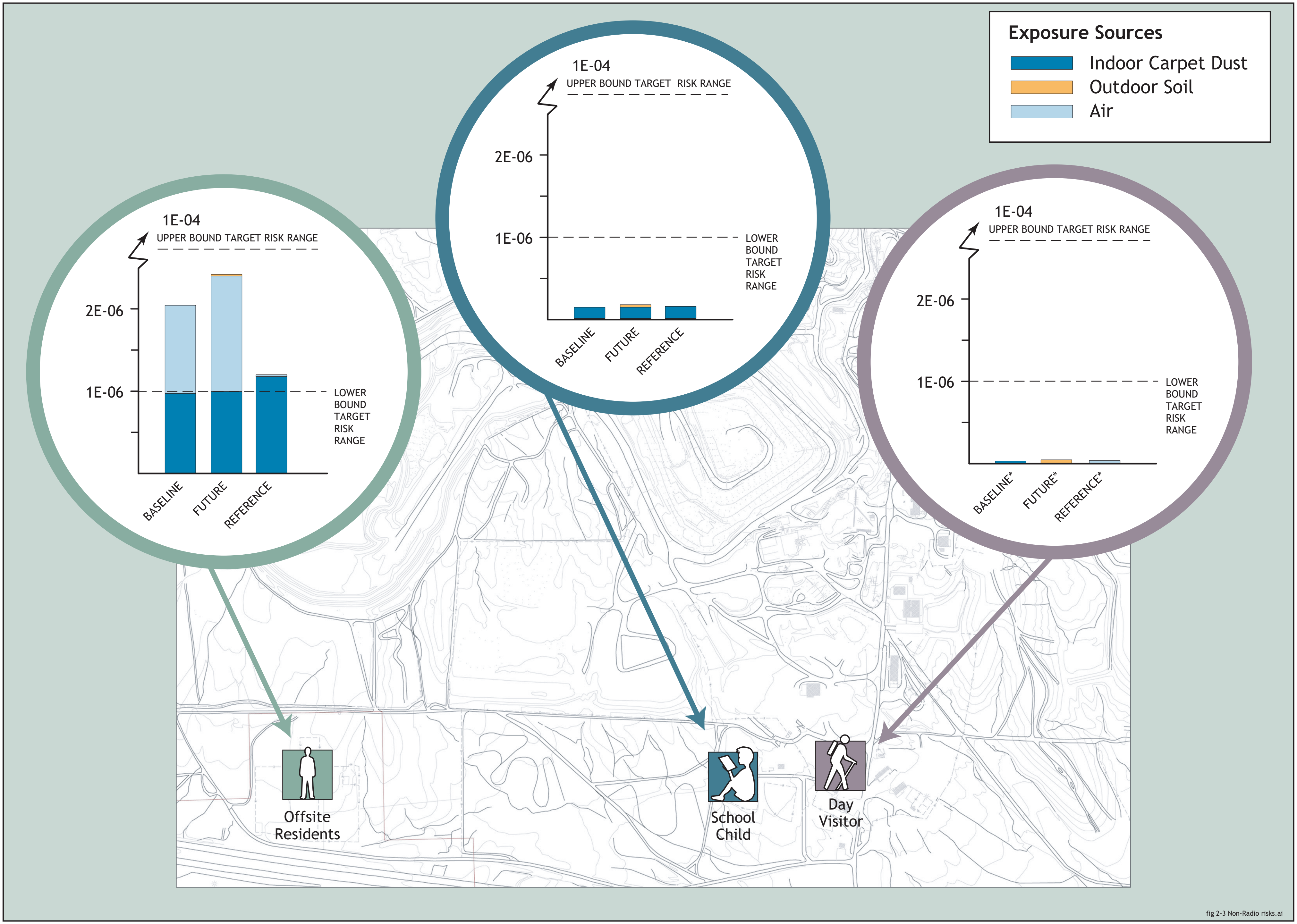


Figure 2-3. Comparison of Baseline, Future, and Reference non-radiological cancer risk estimates for three groups of receptors. Risk estimates are shown according to the sources of exposure that contribute to the total risk.

*Note: The risk estimates for day visitors for the baseline, future, and reference scenario are 1.3×10^{-9}, 3.7×10^{-8}, and 4×10^{-9}, respectively.

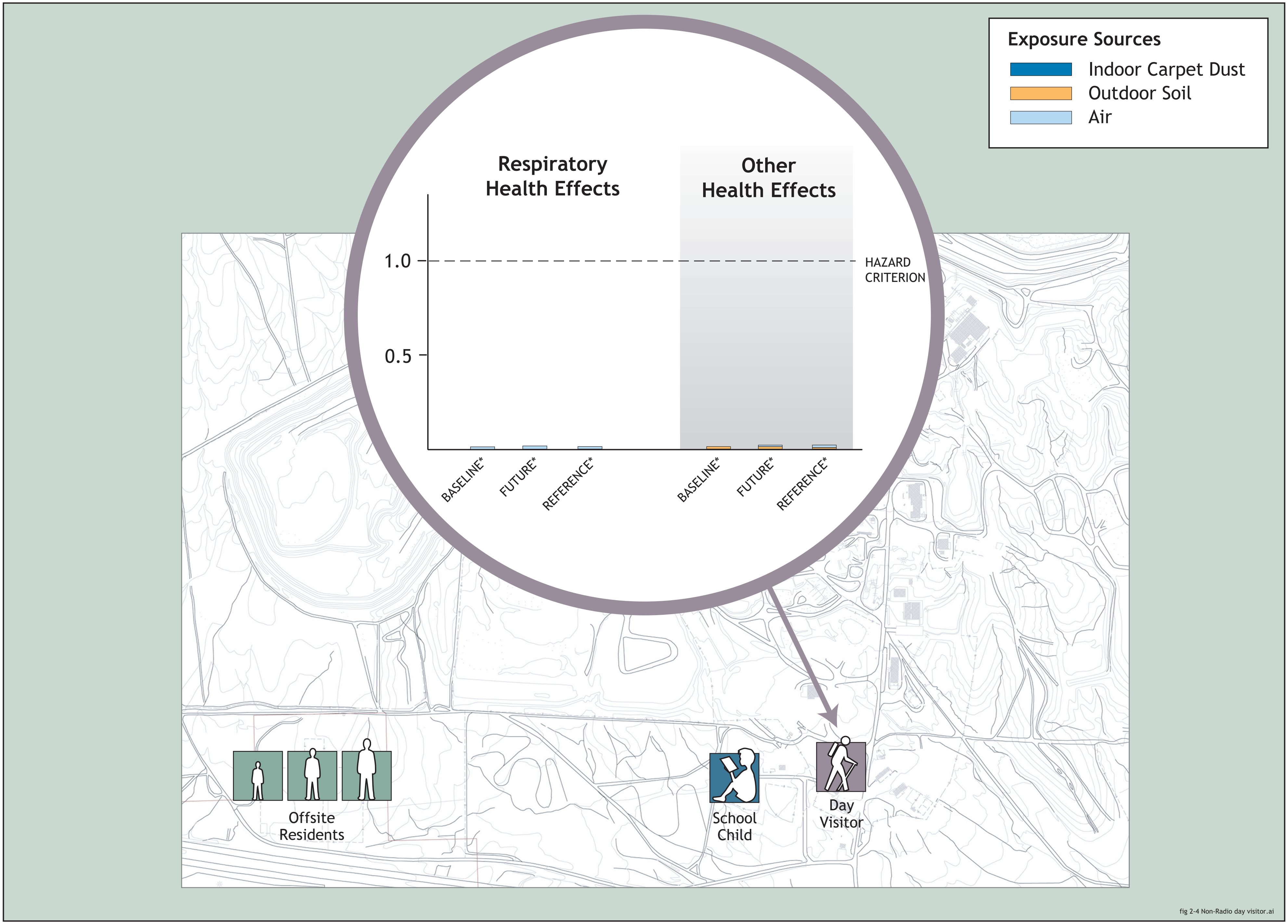


Figure 2-4. Comparison of Baseline, Future, and Reference noncancer health hazard estimates for the Day Visitor. Estimates grouped by potential health effects and by source of exposure.

*Note: The HIs for respiratory effects are 0.03, 0.03, and 0.003 for baseline, future, and reference scenario, respecitvely. The HIs for other health effects are 0.008, 0.01, and 0.01 for the baseline, future, and reference scenario, respectively.

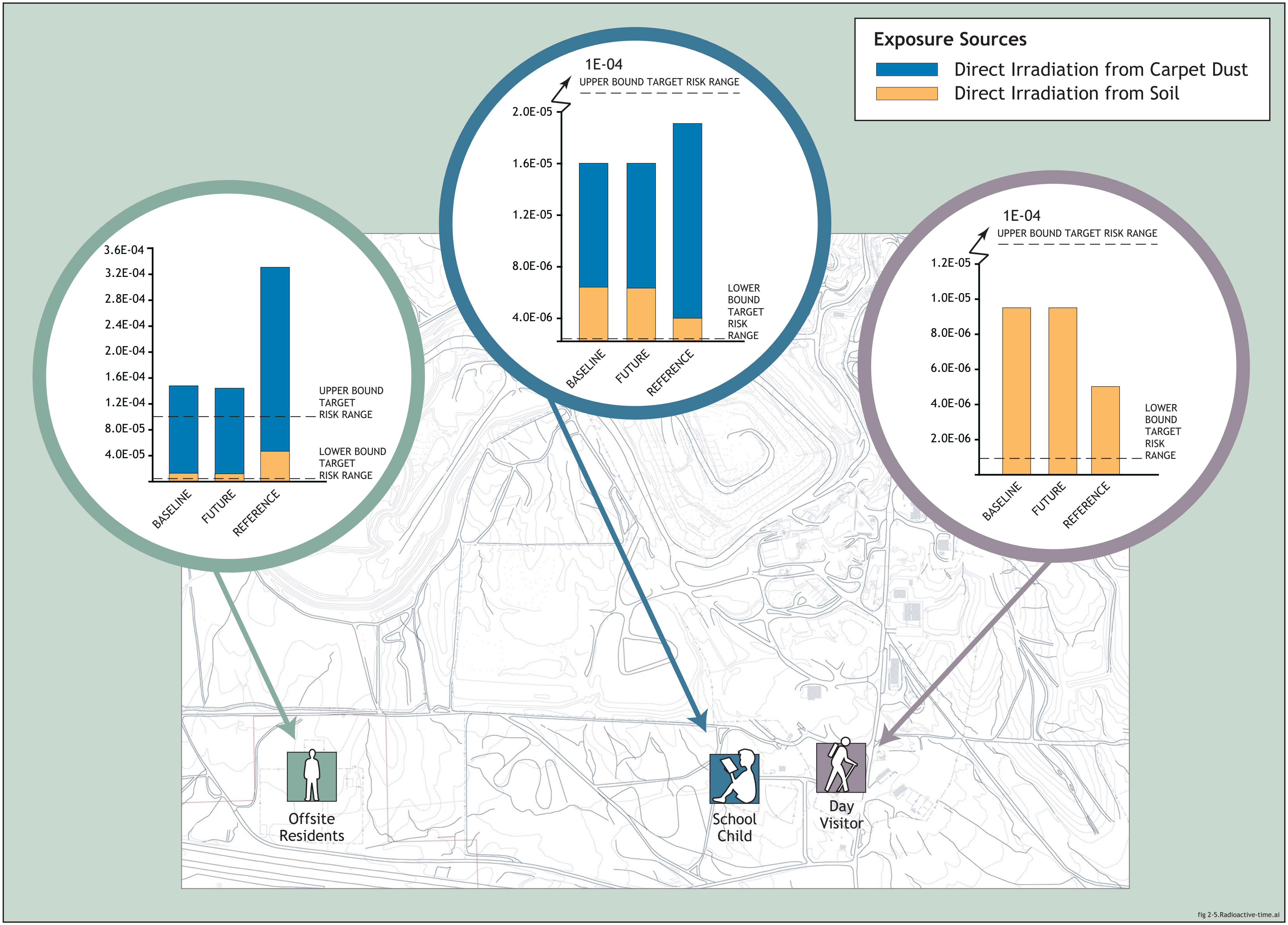


Figure 2-5. Comparison of Baseline, Future, and Reference radiological cancer risk estimates for three groups of receptors. Risk estimates are shown according to the sources of exposure that contribute to the total risk.

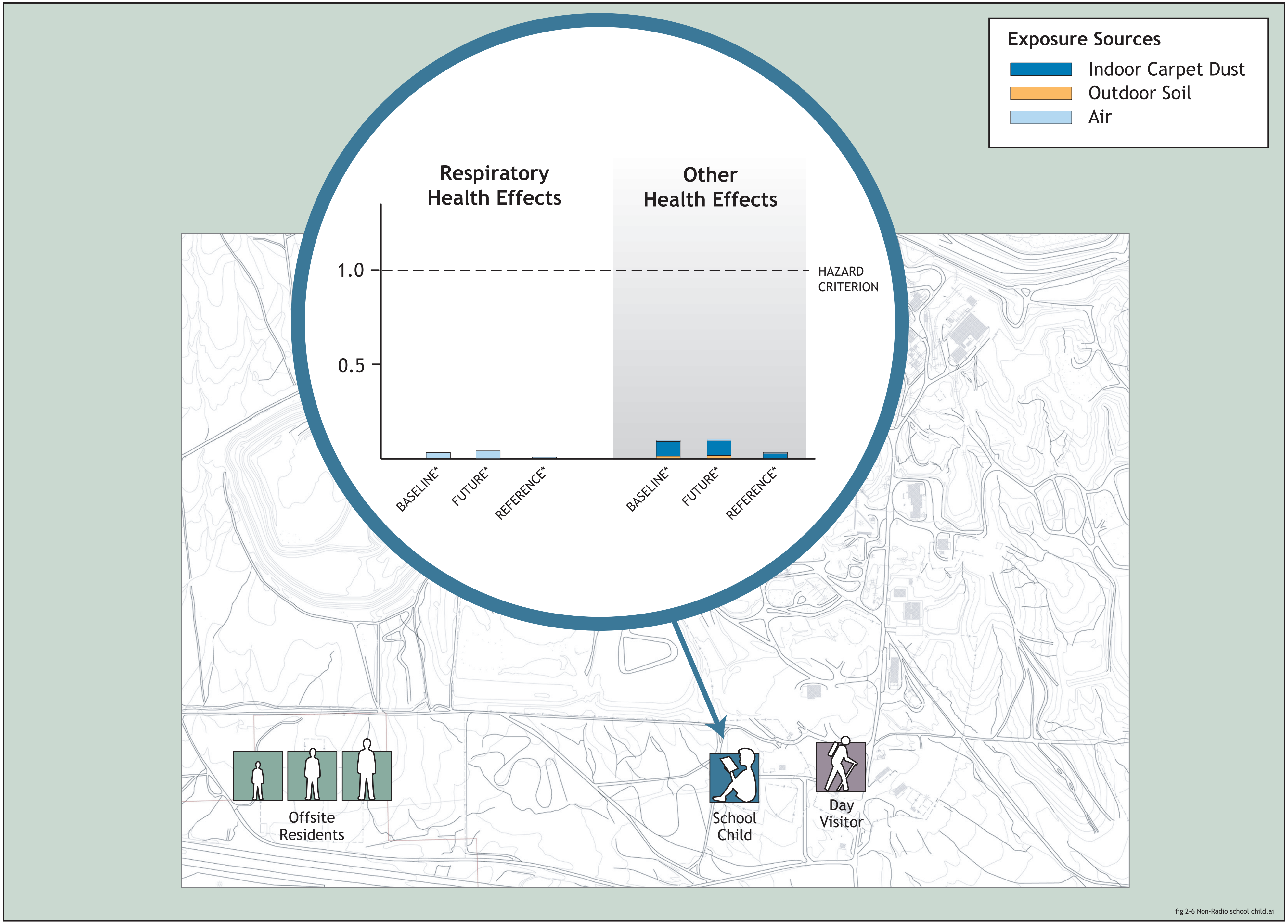


Figure 2-6. Comparison of Baseline, Future, and Reference noncancer health hazard estimates for the school child. Estimates grouped by potential health effects and by source of exposure.

*Note: The HIs for respiratory health effects are 0.05, 0.06, and 0.006 for baseline, future, and reference scenario, respectively. The HIs for other health effects are 0.14, 0.16, and 0.04 for the baseline, future, and reference scenario, respectively.

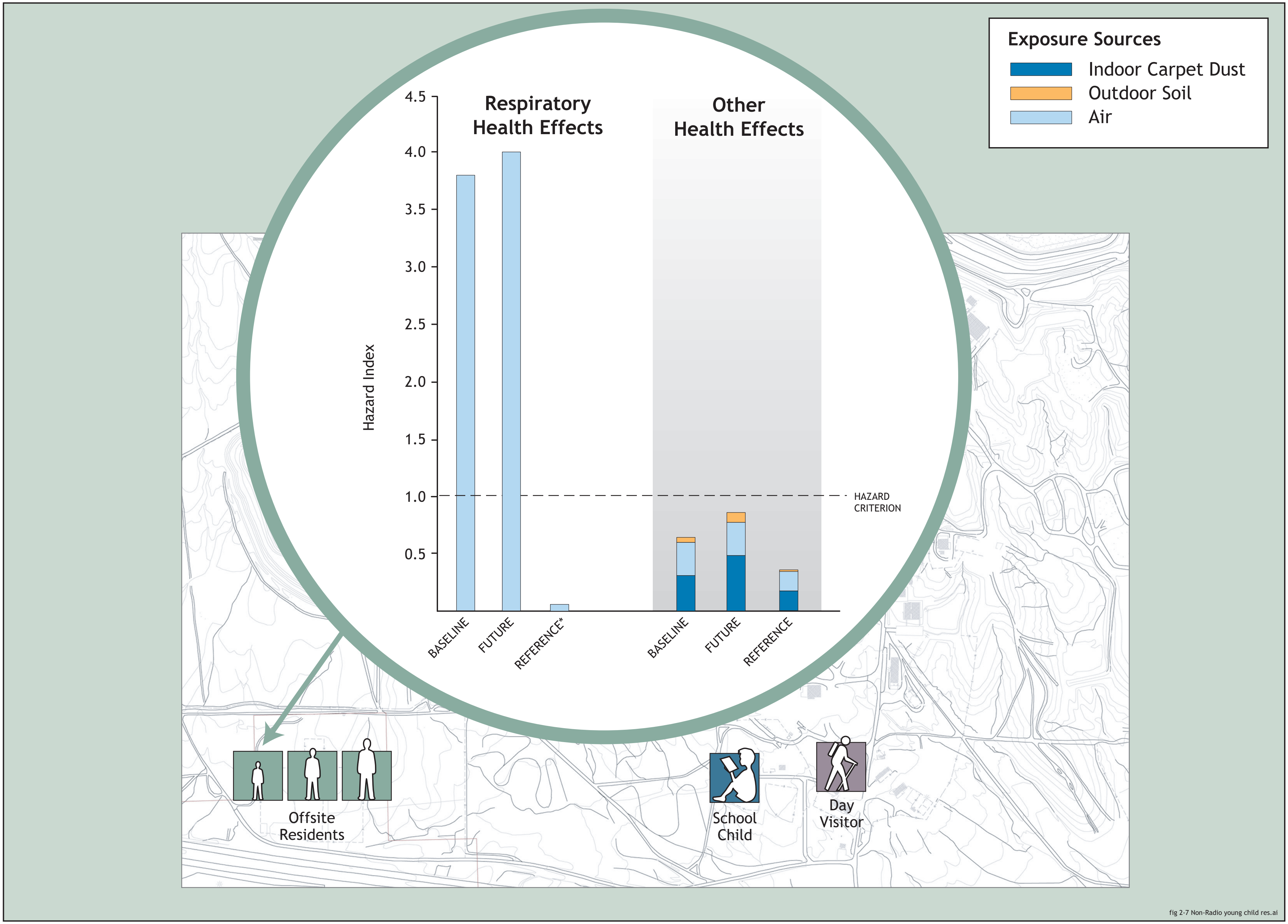


Figure 2-7. Comparison of Baseline, Future, and Reference noncancer health hazard estimates for young child offsite residents. Estimates grouped by potential health effects and by source of exposure.

*Note: The HI for respiratory health effects for the reference scenario is 0.08.

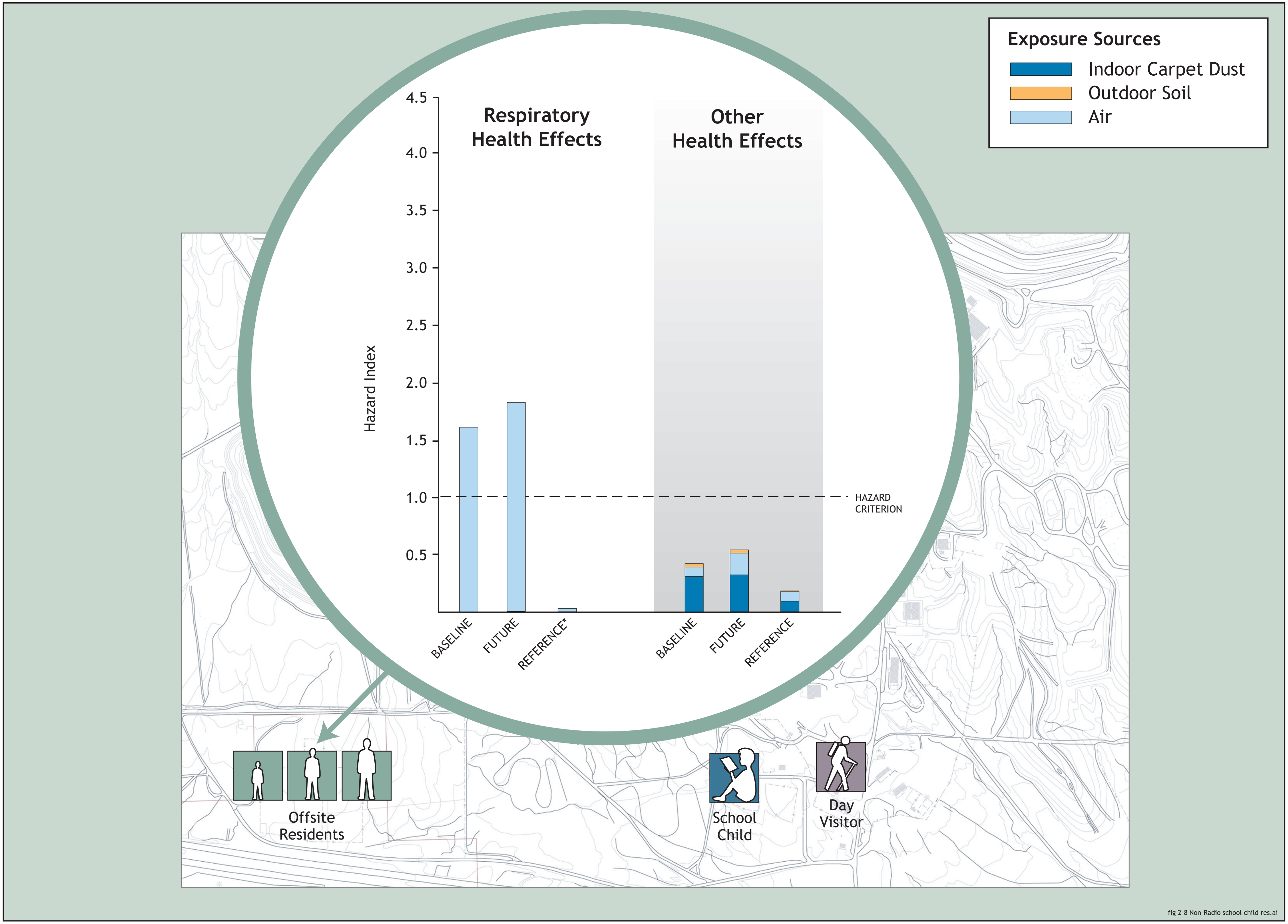


Figure 2-8. Comparison of Baseline, Future, and Reference noncancer health hazard estimates for school age offsite residents. Estimates grouped by potential health effects and by source of exposure.

*Note: The HI for respiratory health effects for the reference scenario is 0.04.

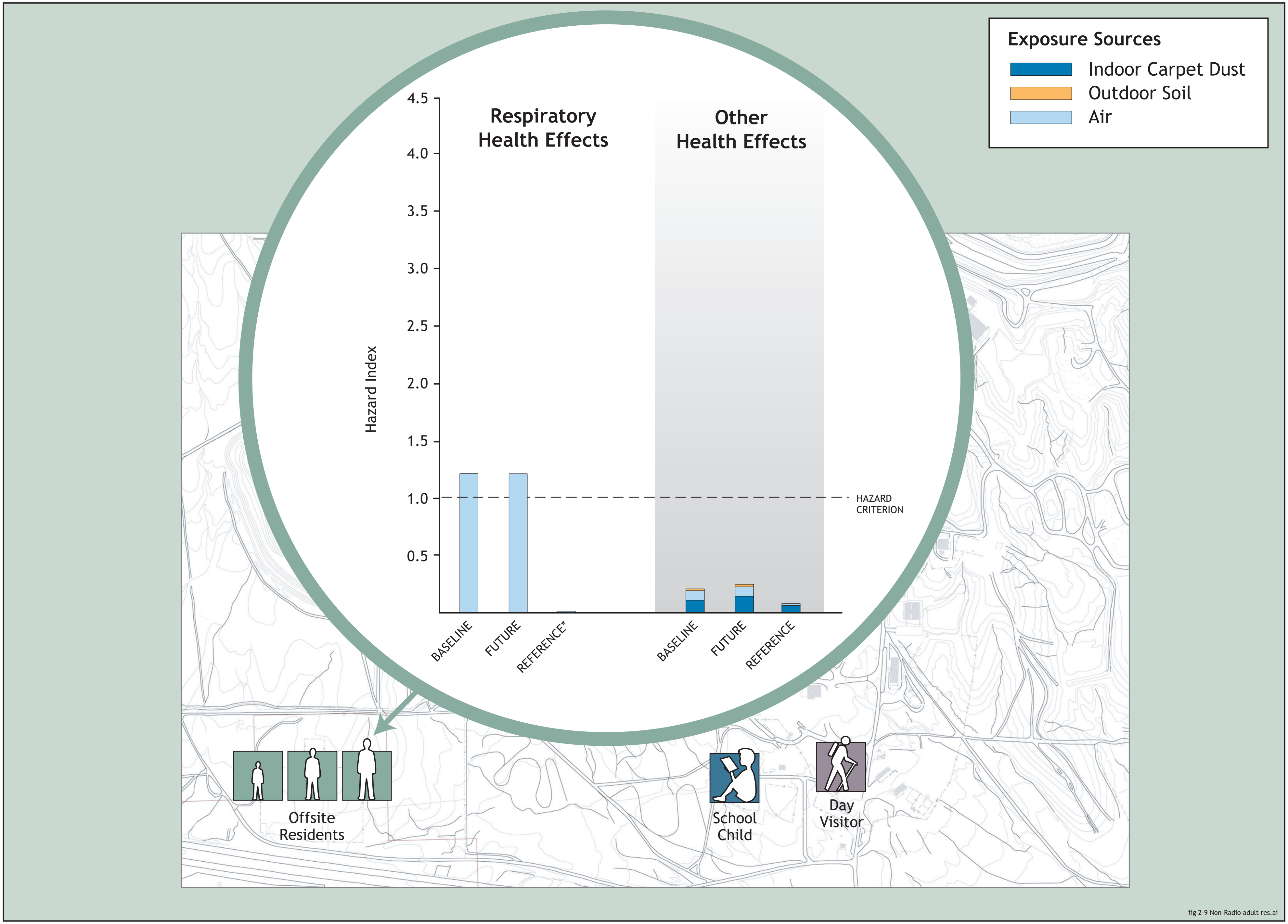


Figure 2-9. Comparison of Baseline, Future, and Reference noncancer health hazard estimates for adult offsite residents under three different exposure scenarios. Estimates grouped by potential health effects.

*Note: The HI for respiratory health effects for the reference scenario is 0.03.

Table 2-1
Background Soil Data Used to Identify COPCs and to Characterize the Reference Scenario

Area of Concern	Background Soil Types Found at or Near AOC [based on geologic map]	Background Soil Type Used to Identify COPCs[1]			Background Soil Types Used to Characterize the Reference Exposure Scenario
		Metals & Actinides	Lanthanides	RadChem	
Mine and Mill Site					
• Warehouse	YA, OA	YA	YA	YA	YA, OA
Offsite					
• Mountain Pass Elementary School	YA	YA	YA	YA	YA
• CHP residences	YA	YA	YA	YA	YA

Notes:

1 = Background data were selected because they provide protective and defensible screening values relative to other possible COPC screening values.
OA = Older alluvium
YA = Younger alluvium

Table 2-2
Constituents of Potential Concern in Soil, Indoor Carpet Dust, and Air at Human Receptor Locations

	Mountain Pass Elementary School						Offsite Residences						Warehouse			
Constituent	Baseline Soils[1]	Future Incremental Soils[2]	Baseline Indoor Carpet Dust[1]	Future Indoor Carpet Dust[3]	Baseline Air[4]	Future Air[4]	Baseline Soils[1]	Future Incremental Soils[2]	Baseline Indoor Carpet Dust[5]	Future Indoor Carpet Dust[3]	Baseline Air[4]	Future Air[4]	Baseline Soils[1]	Future Incremental Soils[2]	Baseline Air[4]	Future Air[4]
Metals																
Aluminum		●	●	●	●	●		●	●	●	●	●		●	●	●
Antimony		●			●	●		●			●	●		●	●	●
Arsenic		●	●	●	●	●		●	●	●	●	●		●	●	●
Barium	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Beryllium		●			●	●		●			●	●	●	●	●	●
Cadmium	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Chromium III			●	●					●	●			●			
Chromium VI		●		●	●	●		●		●	●	●		●	●	●
Cobalt			●	●					●	●			●			
Copper			●	●					●	●			●			
Lead	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●
Manganese		●			●	●		●			●	●	●	●	●	●
Mercury		●	●	●	●	●		●	●	●	●	●		●	●	●
Molybdenum							●						●			
Nickel		●	●	●	●	●		●	●	●	●	●	●	●	●	●
Selenium	●												●			
Silver							●						●			
Strontium	●		●	●			●		●	●			●			
Thallium	●												●			
Vanadium			●	●					●	●			●			
Zinc	●		●	●			●		●	●			●			
Lanthanide Metals																
Lanthanides (group)		●		●	●	●		●		●	●	●		●	●	●
Cerium	●		●	●					●	●			●			
Dysprosium	●		●	●					●	●			●			
Erbium	●		●	●					●	●			●			
Europium	●		●	●					●	●			●			
Gadolinium	●		●	●					●	●			●			
Holmium													●			
Lanthanum	●		●	●					●	●			●			
Lutetium													●			
Neodymium	●		●	●					●	●			●			
Praseodymium	●		●	●					●	●			●			
Samarium	●		●	●					●	●			●			

Table 2-2
Constituents of Potential Concern in Soil, Indoor Carpet Dust, and Air at Human Receptor Locations

	Mountain Pass Elementary School						Offsite Residences						Warehouse			
Constituent	Baseline Soils[1]	Future Incremental Soils[2]	Baseline Indoor Carpet Dust[1]	Future Indoor Carpet Dust[3]	Baseline Air[4]	Future Air[4]	Baseline Soils[1]	Future Incremental Soils[2]	Baseline Indoor Carpet Dust[5]	Future Indoor Carpet Dust[3]	Baseline Air[4]	Future Air[4]	Baseline Soils[1]	Future Incremental Soils[2]	Baseline Air[4]	Future Air[4]
Terbium	●		●	●					●	●			●			
Thulium																
Ytterbium													●			
Yttrium			●	●					●	●			●			
Actinide Metals																
Thorium			●	●					●	●			●			
Uranium			●	●					●	●			●			
Other inorganics																
Chlorine					●	●					●	●			●	●
Hydrochloric Acid					●	●					●	●			●	●
Phosphorus		●			●	●		●			●	●		●	●	●
Sodium		●			●	●		●			●	●		●	●	●
Organics																
Acetaldehyde					●	●					●	●			●	●
Acrolein					●	●					●	●			●	●
Benzene					●	●					●	●			●	●
Benzo(a)anthracene					●	●					●	●			●	●
Benzo(a)pyrene					●	●					●	●			●	●
Benzo(b)fluoranthene					●	●					●	●			●	●
Benzo(k)fluoranthene					●	●					●	●			●	●
1,3-Butadiene					●	●					●	●			●	●
Chrysene					●	●					●	●			●	●
Crotonaldehyde					●	●					●	●			●	●
Dibenz(a,h)anthracene					●	●					●	●			●	●
Ethylbenzene					●	●					●	●			●	●
Formaldehyde					●	●					●	●			●	●
Indeno(1,2,3-c,d)pyrene					●	●					●	●			●	●
Naphthalene					●	●					●	●			●	●
o-Xylene					●	●					●	●			●	●
PAH (Total)					●	●					●	●			●	●
Propionaldehyde					●	●					●	●			●	●
Toluene					●	●					●	●			●	●
Trimethylbenzene					●	●					●	●			●	●
Xylenes					●	●					●	●			●	●

Table 2-2
Constituents of Potential Concern in Soil, Indoor Carpet Dust, and Air at Human Receptor Locations

	Mountain Pass Elementary School						Offsite Residences						Warehouse			
Constituent	Baseline Soils[1]	Future Incremental Soils[2]	Baseline Indoor Carpet Dust[1]	Future Indoor Carpet Dust[3]	Baseline Air[4]	Future Air[4]	Baseline Soils[1]	Future Incremental Soils[2]	Baseline Indoor Carpet Dust[5]	Future Indoor Carpet Dust[3]	Baseline Air[4]	Future Air[4]	Baseline Soils[1]	Future Incremental Soils[2]	Baseline Air[4]	Future Air[4]
<u>Radionuclides*</u>																
Thorium-232 + daughter products																
Th-232	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●
Ra-228		●	●	●	●	●		●	●	●	●	●	●	●	●	●
Ac-228													●			
Th-228	●		●	●					●	●			●			
Ra-224													●			
Pb-212			●	●					●	●			●			
Tl-208	●												●			
Uranium-238 + daughter products																
U-238	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●
U-234	●		●	●			●		●	●			●			
Th-230			●	●					●	●			●			
Ra-226	●	●			●	●	●	●			●	●	●	●	●	●
Pb-214													●			
Bi-214	●		●	●			●		●	●			●			
Uranium-235 + daughter products																
U-235	●		●	●			●		●	●			●			
Ra-223																

Notes:

1 measured
2 predicted by deposition modeling
3 estimated by calculating percent increase in soil as applied to current measured or estimated indoor carpet dust concentrations
4 predicted by air modeling
5 estimated by applying ratios between indoor and outdoor constituent concentrations at MPES to constituent concentrations in outdoor soils at residences.

● constituent of potential concern in soil (selected by Wilcoxon Rank Sum)
● constituent of potential concern in soil (selected because insufficient sample size for reference or AOC data sets to conduct WRS)
● constituent of potential concern in soil (selected because reference or AOC data sets contained >50% nondetected values)
● constituent of potential concern in indoor carpet dust
● constituent of potential concern in air

* Radionuclides were grouped into their respective decay chains; see Table 2-2c.
K-40 is not evaluated as a COPC. This radioisotope is naturally occurring, ubiquitous and not considered to be related to activities at the site.

Table 2-3
Radionuclide Decay Chains

Principal radioisotope	Thorium-232	Uranium-238	Uranium-235 (Actinium decay chain)
Daughter products	Th-232	U-238	U-235
	Ra-228	Th-234	Th-231
	Ac-228	Pa-234m	Pa-231
	Th-228	Pa-234	Ac-227
	Ra-224	U-234	Th-227
	Rn-220	Th-230	Fr-223
	Po-216	Ra-226	Ra-223
	Pb-212	Rn-222	Rn-219
	Bi-212	Po-218	Po-215
	Po-212	Pb-214	Pb-211
	Tl-208	At-218	Bi-211
		Bi-214	Po-211
		Po-214	Tl-207
		Tl-210	
		Pb-210	
		Bi-210	
		Po-210	

Source:

U.S. EPA. 2001. Health Effects Assessment Summary Tables (HEAST)
- Radionuclides Tables. Available on-line at http://www.epa.gov/radiation/heast/

Table 2-4
Constituents of Potential Concern in Reference Soil, Reference Indoor Carpet Dust, and Reference Air at Human Receptor Locations

	Mountain Pass Elementary School			Offsite Residences			Warehouse[4]	
Constituent	Reference Soils[1]	Reference Indoor Carpet Dust[2]	Reference Air[3]	Reference Soils[1]	Reference Indoor Carpet Dust[2]	Reference Air[3]	Reference Soils[1]	Reference Air[3]
Metals								
Aluminum		●	●		●	●		●
Antimony			●			●		●
Arsenic		●	●		●	●		●
Barium	●	●	●	●	●	●	●	●
Beryllium			●			●	●	●
Cadmium	●	●	●	●	●	●	●	●
Chromium III		●			●		●	
Chromium VI								
Cobalt		●			●		●	
Copper		●			●		●	
Lead	●	●	●		●	●	●	●
Manganese			●			●	●	●
Mercury		●	●		●	●		●
Molybdenum				●			●	
Nickel		●	●		●	●	●	●
Selenium	●						●	
Silver				●			●	
Strontium	●	●		●	●		●	
Thallium	●						●	
Vanadium		●			●		●	
Zinc	●	●		●	●		●	
Lanthanide Metals								
Cerium	●	●	●		●	●	●	●
Dysprosium	●	●	●		●	●	●	●
Erbium	●	●	●		●	●	●	●
Europium	●	●	●		●	●	●	●
Gadolinium	●	●	●		●	●	●	●
Holmium			●			●	●	●
Lanthanum	●	●	●		●	●	●	●
Lutetium			●			●	●	●
Neodymium	●	●	●		●	●	●	●
Praseodymium	●	●	●		●	●	●	●
Samarium	●	●	●		●	●	●	●
Terbium	●	●	●		●	●	●	●
Thulium			●			●		●
Ytterbium			●			●	●	●
Yttrium		●	●		●	●	●	●
Actinide Metals								
Thorium		●			●		●	
Uranium		●			●		●	
Other inorganics								
Chlorine								
Hydrochloric Acid								
Phosphorus								
Sodium								

Table 2-4
Constituents of Potential Concern in Reference Soil, Reference Indoor Carpet Dust, and Reference Air at Human Receptor Locations

	Mountain Pass Elementary School			Offsite Residences			Warehouse[4]	
Constituent	Reference Soils[1]	Reference Indoor Carpet Dust[2]	Reference Air[3]	Reference Soils[1]	Reference Indoor Carpet Dust[2]	Reference Air[3]	Reference Soils[1]	Reference Air[3]
Organics								
Acetaldehyde								
Acrolein								
Benzene								
Benzo(a)anthracene								
Benzo(a)pyrene								
Benzo(b)fluoranthene								
Benzo(k)fluoranthene								
1,3-Butadiene								
Chrysene								
Crotonaldehyde								
Dibenz(a,h)anthracene								
Ethylbenzene								
Formaldehyde								
Indeno(1,2,3-c,d)pyrene								
Naphthalene								
o-Xylene								
PAH (Total)								
Propionaldehyde								
Toluene								
Trimethylbenzene								
Xylenes								
Radionuclides*								
Thorium-232 + daughter products								
Th-232	●	●	●	●	●	●	●	●
Ra-228		●	●	●	●	●	●	●
Ac-228							●	
Th-228	●	●			●		●	
Ra-224							●	
Pb-212		●			●		●	
Tl-208	●						●	
Uranium-238 + daughter products								
U-238	●	●	●		●	●	●	●
U-234	●	●		●	●		●	
Th-230		●			●		●	
Ra-226	●		●	●		●	●	●
Pb-214							●	
Bi-214	●	●		●	●		●	
Uranium-235 + daughter products								
U-235								
Ra-223								

Table 2-4

Constituents of Potential Concern in Reference Soil, Reference Indoor Carpet Dust, and Reference Air at Human Receptor Locations

	Mountain Pass Elementary School			Offsite Residences			Warehouse[4]	
Constituent	Reference Soils[1]	Reference Indoor Carpet Dust[2]	Reference Air[3]	Reference Soils[1]	Reference Indoor Carpet Dust[2]	Reference Air[3]	Reference Soils[1]	Reference Air[3]

Notes:

1 reference soil COPCs based on baseline soil COPCs

2 reference indoor carpet dust COPCs selected based on baseline indoor carpet dust COPCs; reference soil concentrations used as surrogate reference indoor dust concentrations.

3 reference air COPCs are the same set of COPCs determined ENVIRON (2000a).

4 Soil COPCs apply to both Young and Old Alluvium Background soils.

● constituent of potential concern in soil

● constituent of potential concern in indoor carpet dust

● constituent of potential concern in air

* Radionuclides were grouped into their respective decay chains, see Table 2-3

Thorium-232+d as a COPC in soils at the Offsite Residences is based on future deposition of Th-232 and Ra-228.

K-40 is not evaluated as a COPC. This radioisotope is naturally occurring, ubiquitous and not considered to be related to activities at the site.

Table 2-5

Criteria Used to Identify Receptors for Quantitative Exposure and Risk Analyses

Criteria[1]	Rationale
1. Is the receptor group onsite?	U.S. EPA guidance (1989a) recommends characterizing risks to populations on or near a release site because these receptors may have the greatest potential for exposure to chemicals of potential concern.
2. Is the receptor group a set of sensitive individuals or does it contain potentially sensitive individuals?	Sensitive individuals may be at increased risk from chemical exposures due to increased sensitivity or behavior patterns that may result in high exposure. Subpopulations of particular concern include infants and children, who are more likely to contact soil.
3. Is the receptor group likely to be exposed to chemicals of potential concern via one or more exposure pathways?	Exposure to COPCs by several exposure pathways, such as incidental soil ingestion and inhalation of airborne dusts, is likely to result in greater levels of exposure than would occur by only one of the exposure pathways. In other words, likely levels of exposure are correlated with an increase in the number of exposure pathways by which a receptor is potentially exposed to COPCs.
4. Which receptor group is likely to be exposed frequently and/or for a long duration?	Likely levels of exposure are correlated with an increase in the frequency and duration of receptor exposure to COPCs.
5. Which receptor group is exposed to the highest levels of chemicals of potential concern, in particular those concentrations predicted by air modeling?	If all other factors appear similar, the receptor group likely to have the highest level of exposure is selected on the basis of measured or modeled exposure concentrations. Those situated at a location where the highest levels of a chemical are predicted to occur are identified as the "maximally exposed individual" for a specific environmental medium.

[1] Sequential application of these criteria, demonstrating the selection of receptors for quantitative evaluation, is shown in Table 2-6.

Table 2-6
Weight-of-Evidence Used in Selecting Receptor Groups for Quantitative Risk Analysis

Mine & Mill Site		Exposure Factors						
Area	**Receptors**	**Onsite?**	**Sensitive Receptors?**	**Greater than One Exposure Route?**	**Frequent Chronic Exposure?**			**Proximity to Source Areas**
					Soil Contact	**Inhalation**	**Groundwater**	
Onsite[a]	**Day Visitor**	Y	N	Y	Y	Y	NA	Close
	Tour group	Y	N	Y	N	N	NA	Close
Nearby	**School children**	N[b]	Y	Y	Y	Y	NA	Close
	School teacher/aides	N[b]	N	Y	N	Y	N	Close
	Nearby residents	N[b]	Y	Y	Y	Y	*Future hypothetical*	Close
	Caltrans worker	N	N	Y	Y	Y	N	Close
	Post Office workers	N	N	Y	Y	Y	N	Close
	BLM Workers	N	N	N	N	N	N	Distant
	NPS Workers	N	N	N	N	N	N	Distant
	Highway traveler	N	Y	N	N	N	N	Distant
	Trail Users	N	N	N	N	N	N	Distant

Notes:

a = Health hazards for mine workers are monitored under the mine's industrial hygiene program.

b = Measured chemical concentrations at or near receptor location.

Y = Yes

N = No

NA = Not applicable

BLM = Bureau of Land Management

BLM = National Park Service

Bold Receptor groups selected for estimating exposures and risks.

Table 2-7
Pathway-Specific Formulas
Used for Chemical Exposure Calculations

INCIDENTAL SOIL INGESTION	DERMAL EXPOSURE TO SOIL
$$Intake\,(mg/kg/day) = \frac{C_s \times CF \times IR_s \times ET \times EF \times ED}{BW \times AT}$$ where C_S = Chemical concentration in soil (mg/kg) CF = Conversion factor for chemical fraction of soil (10^{-6} = kg/mg) IR = Ingestion rate (mg/day) ET_s = Exposure time (fraction of day, unitless) EF = Exposure frequency (days/year) ED = Exposure duration (years) BW = Body weight (kg) AT = Averaging time for pathway-specific exposure period (days)	$$Intake\,(mg/kg/day) = \frac{C_s \times CF \times SA \times AF \times ET_S \times ABS \times EF \times ED}{BW \times AT}$$ where C_S = Chemical concentration in soil (mg/kg) CF = Conversion factor for chemical fraction of soil (10^{-6} = kg/mg) SA = Exposed skin surface area (cm^2/day) AF = Soil adherence factor (mg/cm^2) ET_s = Exposure time (fraction of day, unitless) ABS= Chemical absorption fraction EF = Exposure frequency (days/year) ED = Exposure duration (years) BW = Body weight (kg) AT = Averaging time for pathway-specific exposure period (days)
INHALATION EXPOSURE	
$$Intake\,(mg/kg/day) = \frac{C_a \times IN \times ET_i \times EF \times ED}{BW \times AT}$$ where C_a = Chemical concentration in air (mg/m^3) IN = Inhalation rate (m^3/day) ET_i = Exposure time (fraction of day, unitless) EF = Exposure frequency (days/year) ED = Exposure duration (years) BW = Body weight (kg) AT = Averaging time for pathway-specific exposure period (days)	

Table 2-8
Pathway-Specific Formulas
Used for Radiological Risk Calculations

DIRECT IRRADIATION	INHALATION OF AIRBORNE DUST
Risk = Cs x FY x ED x RU Where: C_S = Concentration of radionuclide in soil (pCi/g) FY = Fraction of year exposure ED = Exposure duration (yr) RU = Risk per unit activity concentration $(pCi/g)^{-1}$	Risk = Ca x FY x ED x IR x RU Where: C_a = Radionuclide concentration in air (pCi/m^3) FY = Fraction of year exposure ED = Exposure duration (yr) IR = Inhalation rate ($m^3\ yr^{-1}$) RU = Risk per unit inhaled concentration $(pCi)^{-1}$
INCIDENTAL INGESTION OF SOIL Risk = Cs x IR x EF x ED x RU Where: C_S = Concentration of radionuclide in soil (pCi/g) IR = soil ingestion rate (grams/day) EF = Exposure frequency (days/year) ED = Exposure duration (year) RU = Risk per unit ingested activity $(pCi)^{-1}$	

Table 2-9

Exposure Parameters for Outdoor Soil, Indoor Carpet Dust, and Air Exposures

Pathway	Variable	Parameter	Value	Units	Source/Rationale
Soil and Carpet Dust Ingestion					
	C_s	**Chemical concentration in soil or carpet dust**	Estimated	mg/kg	Units for outdoor soil or indoor carpet dust
	CF	**Conversion Factor for chemical fraction of soil or carpet dust**	10^{-6}	kg/mg	-
	IR	**Outdoor Soil and Indoor Carpet Dust Ingestion Rate**			
		School children, ages 5 to 12 years	64	mg/day	The combined soil and indoor carpet dust ingestion rate is based on incidental soil ingestion rates of 100 mg/day for two years (ages 5 and 6 years)[2] and 50 mg/day for five years (ages 7 through 11 years) (U.S. EPA 1997b). Also, assumes that outdoor soil comprises half of the incidental soil ingestion (32 mg/d); indoor carpet dust comprises the other half (32 mg/d)[1] (U.S. EPA 1994).
		Offsite (Caltrans/CHP) Resident,			
		child, ages 1 to 4 years	100	mg/day	The combined outdoor soil and indoor carpet dust ingestion rate is the value recommended for evaluating incidental soil ingestion (U.S. EPA 1997b). Also, assumes that outdoor soil comprises half of the incidental soil ingestion (50 mg/d); indoor carpet dust comprises the other half (50 mg/d)[1,2] (U.S. EPA 1994).
		child, ages 5 to 12 years	64	mg/day	The combined soil and indoor carpet dust ingestion rate is based on incidental soil ingestion rates of 100 mg/day for two years (ages 5 and 6 years)[2] and 50 mg/day for five years (ages 7 through 11 years) (U.S. EPA 1997b). Also, assumes that outdoor soil comprises half of the incidental soil ingestion (32 mg/d); indoor carpet dust comprises the other half (32 mg/d)[1] (U.S. EPA 1994).
		older child and adult	50	mg/day	The combined outdoor soil and indoor carpet dust ingestion rate is the value recommended for evaluating incidental soil ingestion; U.S. EPA 1997b. Also, assumes that outdoor soil comprises half of the incidental soil ingestion (25 mg/d); indoor carpet dust comprises the other half (25 mg/d)[1] (U.S. EPA 1994).
		Day Visitor (e.g., truck driver)	50	mg/day	U.S. EPA 1997b

Table 2-9
Exposure Parameters for Outdoor Soil, Indoor Carpet Dust, and Air Exposures

Pathway	Variable	Parameter	Value	Units	Source/Rationale
	ET_S	**Fraction of time incidentally ingesting outdoor soil**			
		School children, ages 5 to 12 years	0.14	unitless	Based on time spent contacting outdoor soil at school relative to time spent at home (see Appendix IV.1-2 to IV.1-5).
		Offsite (Caltrans/CHP) Resident,			
		child, ages 1 to 4 years	1	unitless	Assumes all outdoor soil exposure occurs at home.
		child, ages 5 to 12 years	0.86	unitless	Based on time spent contacting outdoor soil at home relative to time spent at school (see Appendix IV.1-2 to IV.1-5).
		older child and adult	1	unitless	Assumes all outdoor soil exposure for an older child and adult occurs at home.
		Day Visitor (e.g., truck driver)	0.125	unitless	Approximately 1 hour of each 8-hour work-day is assumed to be spent at mine site (S.Rogan 1999)
	$ET_{S,D}$	**Fraction of time incidentally ingesting indoor carpet dust**			
		School children, ages 5 to 12 years	0.25	unitless	Based on time spent contacting indoor carpet dust at school relative to time spent indoors at home (see Appendix IV.1-2 to IV.1-5).
		Offsite (Caltrans/CHP) Resident,			
		child, ages 1 to 4 years	1	unitless	Assumes all indoor carpet dust exposure occurs at home.
		child, ages 5 to 12 years	0.75	unitless	Based on time spent contacting indoor carpet dust at home relative to time spent indoors at school (see Appendix IV.1-2 to IV.1-5).
		older child and adult	0.65	unitless	Based on time spent contacting indoor carpet dust at home relative to time spent away from home (see Appendix IV.1-2 to IV.1-5).
<u>Soil and Carpet Dust Dermal Contact</u>					
	SA	**Skin Surface Area**			
		School children, ages 5 to 12 years	2920	cm^2	25% of body surface area (hands, lower legs, forearms, head) U.S. EPA 1991a, 1992a, 1997b
		Offsite (Caltrans/CHP) Resident,			
		child, ages 1 to 4 years	1230	cm^2	25% of body surface area (hands, lower legs, forearms, head) U.S. EPA 1991a, 1992a, 1997b
		child, ages 5 to 12 years	2920	cm^2	25% of body surface area (hands, lower legs, forearms, head) U.S. EPA 1991a, 1992a, 1997b
		older child and adult	5250	cm^2	25% of body surface area (hands, lower legs, forearms, head) U.S. EPA 1991a, 1992a, 1997b
		Day Visitor (e.g., truck driver)	1100	cm^2	Assumes possible hand contact with soil or dust (U.S. EPA, 1997b).

Table 2-9
Exposure Parameters for Outdoor Soil, Indoor Carpet Dust, and Air Exposures

Pathway	Variable	Parameter	Value	Units	Source/Rationale
	ET_S	**Fraction of time contacting outdoor soil**			
		School children, ages 5 to 12 years	0.14	unitless	Exposure time is proportioned between exposure locations following the same approach used to estimate incidental soil ingestion (see Appendix IV.1-2 to IV.1-5).
		Offsite (Caltrans/CHP) Resident,			
		child, ages 1 to 4 years	1	unitless	Assumes all outdoor soil exposure occurs at home.
		child, ages 5 to 12 years	0.86	unitless	Exposure time is assumed to be proportioned between exposure locations following the same approach used to estimate incidental soil ingestion (see Appendix IV.1-2 to IV.1-5).
		older child and adult	1	unitless	Assumes all outdoor soil exposure for an older child and adult occurs at home.
		Day Visitor (e.g., truck driver)	0.125	unitless	Approximately 1 hour of each 8-hour work-day is assumed to be spent at mine site (S.Rogan 1999)
	$ET_{S,D}$	**Fraction of time contacting indoor carpet dust**			
		School children, ages 5 to 12 years	0.25	unitless	Exposure time is assumed to be proportioned between exposure locations following the same approach used to estimate incidental carpet dust ingestion.
		Offsite (Caltrans/CHP) Resident,			
		child, ages 1 to 4 years	1	unitless	Assumes all indoor carpet dust exposure occurs at home.
		child, ages 5 to 12 years	0.75	unitless	Exposure time is assumed to be proportioned between exposure locations following the same approach used to estimate incidental carpet dust ingestion.
		older child and adult	0.65	unitless	Exposure time is assumed to be proportioned between exposure locations following the same approach used to estimate incidental carpet dust ingestion.
	AF	**Outdoor soil and indoor carpet dust Adherence Factor**			
		School children, ages 5 to 12 years	0.3	mg/cm^2	U.S. EPA 1998a; assumed that half of dermal exposure occurs with outdoor soil (0.15 mg/cm^2) and half with indoor carpet dust (0.15 mg/cm^2).
		Offsite (Caltrans/CHP) Resident,			
		child, ages 1 to 4 years	0.3	mg/cm^2	U.S. EPA 1998a; assumed that half of dermal exposure occurs with outdoor soil (0.15 mg/cm^2) and half with indoor carpet dust (0.15 mg/cm^2).
		child, ages 5 to 12 years	0.3	mg/cm^2	U.S. EPA 1998a; assumed that half of dermal exposure occurs with outdoor soil (0.15 mg/cm^2) and half with indoor carpet dust (0.15 mg/cm^2).
		older child and adult	0.08	mg/cm^2	U.S. EPA 1998a; assumed that half of dermal exposure occurs with outdoor soil (0.04 mg/cm^2) and half with indoor carpet dust (0.04 mg/cm^2).
		Day Visitor (e.g., truck driver)	0.08	mg/cm^2	U.S. EPA 1998a
	ABS	**Absorption Fraction**	-	unitless	Chemical-specific (Cal EPA 1994a; U.S. EPA 1992a).

Table 2-9
Exposure Parameters for Outdoor Soil, Indoor Carpet Dust, and Air Exposures

Pathway	Variable	Parameter	Value	Units	Source/Rationale
Inhalation					
	C_a	**Chemical concentration in air**	TBD	mg/m^3	Units for air
	IN	**Inhalation Rate**			
		School children, ages 5 to 12 years	10	m^3/day	U.S. EPA 1991a, 1997b
		Offsite (Caltrans/CHP) Resident,			
		child, ages 1 to 4 years	10	m^3/day	U.S. EPA 1991a, 1997b
		child, ages 5 to 12 years	10	m^3/day	U.S. EPA 1991a, 1997b
		older child and adult	20	m^3/day	U.S. EPA 1991a, 1997b
		Day Visitor (e.g., truck driver)	20	m^3/day	20 m^3 per 8-hour work day; U.S. EPA 1991a.
	ET_I	**Fraction of time inhaling air**			
		School children, ages 5 to 12 years	0.14	unitless	Based on time spent at school relative to time spent at home (see Appendix IV.1-2 to IV.1-5).
		Offsite (Caltrans/CHP) Resident,			
		child, ages 1 to 4 years	1	unitless	Conservative assumption that child is exposed to air at residences for 24 hrs/day (U.S. EPA 1991a).
		child, ages 5 to 12 years	0.86	unitless	Based on time spent at home relative to time spent at school (see Appendix IV Figures and Tables).
		older child and adult	0.75	unitless	Assumes that an older child and adult spend approximately 75 % of their time at home. Time away from home is assumed to be spent at school, shopping, and at recreational or social activities (U.S. EPA 1989b; 1997b).
		Day Visitor (e.g., truck driver)	0.125	unitless	Approximately 1 hour per 8-hr trip spent at mine site (S.Rogan 1999)
General Parameters					
	EF	**Exposure Frequency**			
		School children	180	days/year	T. Novak 1999
		Offsite (Caltrans/CHP) Resident	350	days/year	Conservative assumption (U.S. EPA 1991a); assuming children are home only a fraction of each day during the school year (180 d/yr), but are at home the entire day during weekends and summer vacation (170d/yr).
		Day Visitor (e.g., truck driver)	250	days/year	Based on an assumed daily delivery of reagents by the same truck driver.

Table 2-9
Exposure Parameters for Outdoor Soil, Indoor Carpet Dust, and Air Exposures

Pathway	Variable	Parameter	Value	Units	Source/Rationale
	ED	**Exposure Duration**			
		School children	5	years	Four to five years average attendance period (T. Novak 1999).
		Offsite (Caltrans/CHP) Resident[3]	15	years	Based on maximum duration of worker residency at Mt. Pass; although CHP families average 2-3 yrs residency at Mt. Pass and Caltrans families average 7-8 years residency at Mt. Pass.
		Day Visitor (e.g., truck driver)	6.6	years	Average occupational duration; U.S. EPA 1997b.
	BW	**Body Weight**			
		School children			
		child, ages 5 to 12 years	29.2	kg	Based on an average of body weights for age group (U.S. EPA 1997b)
		Offsite (Caltrans/CHP) Resident			
		child, ages 1 to 4 years	14.3	kg	Based on an average of body weights for age group (U.S. EPA 1997b)
		child, ages 5 to 12 years	29.2	kg	Based on an average of body weights for age group (U.S. EPA 1997b)
		older child and adult	70	kg	Based on an average of body weights for age group (U.S. EPA 1997b)
		Day Visitor (e.g., truck driver)	70	kg	U.S. EPA 1989a, 1991a
	AT	**Averaging Time**			
		Carcinogen	70 years x 365 days/year		Lifetime (U.S. EPA 1989a)
		Non-carcinogen	ED x 365 days/year		U.S. EPA 1989a

Definitions:

TBD To be determined

C_S This and other variable symbols are defined in Tables 2-7 and 2-8.

Notes:

1 Outdoor soil and indoor dust exposures are assumed to occur at the same rates. Outside play at school consists of approximately 55 minutes per day (10 min. recess, 45 min. lunch period (T. Novak 1999).

2 "100 mg/day is the best estimate of the mean [soil ingestion rate] for children under 6 years of age." (U.S. EPA 1997b)

3 Age-adjusted exposures for residents are based on the fractions assumed for the 30-year period used in the U.S. EPA (1991a) default approach; since a school child is assumed to be exposed for 5 years, the remaining 10 years are assumed to be spent part as a young child (2 years) and part as an adult (8 years).

Table 2-10
Summary of Data Types Used for Evaluating the Three Exposure Scenarios

Receptor & Environmental Media	Baseline Scenario	Future Expansion Scenario	Reference Scenario
Day Visitor			
Soil	Measured concentrations at Warehouse	Predicted particulate deposition for Warehouse location used for future incremental exposures	Measured concentrations at Background Soil Locations (Younger and Older Alluvium)
Air	Baseline modeling predictions for Warehouse location	Future modeling predictions (30-year average) for Warehouse location	Combination of annual average airborne dust (PM10) measurements from nearby desert location (Clark County, NV) (ENVIRON 2001) and constituent fractions in background (Younger Alluvium) soils.
MPES Schoolchild			
Soil	Measured concentrations at Mountain Pass Elementary School (MPES)	Predicted particulate deposition at MPES used for future incremental exposures	Measured concentrations at Background Location (Younger Alluvium)
Indoor carpet dust	Measured concentrations in indoor carpet dust at MPES	Estimated, using the fraction increase in outdoor soil concentrations due to future particulate deposition; fraction applied to and summed with concentrations measured in indoor carpet dust.	Measured concentrations in background soil (Younger Alluvium) for constituents of potential concern identified for baseline scenario.
Air	Baseline modeling predictions for MPES.	Future modeling predictions (30-year average) for MPES	Combination of annual average airborne dust (PM10) measurements from nearby desert location (Clark County, NV) (ENVIRON 2001) and constituent fractions in background (Younger Alluvium) soils.

Receptor & Environmental Media	Baseline Scenario	Future Expansion Scenario	Reference Scenario
<u>CHP/Caltrans offsite residents</u>			
Soil	Measured concentrations in the CHP/Caltrans residential area.	Predicted particulate deposition for northern point within the CHP/Caltrans residential area used for future incremental exposures	Measured concentrations at Background Location (Younger Alluvium).
Indoor carpet dust	Estimated, used constituent concentrations in outdoor soil at the residences to estimate indoor concentrations by applying the proportional relationship between indoor and outdoor constituent concentrations at MPES.	Estimated, using the fraction increase in outdoor soil concentrations due to future particulate deposition; fraction applied as an increase to concentrations estimated for the baseline scenario.	Measured concentrations in background soil (Younger Alluvium) for constituents of potential concern identified for baseline scenario (plus thorium-232+d concentrations for comparison to future deposition of thorium)
Air	Baseline modeling predictions for the northern point within the CHP/Caltrans residential area	Future modeling predictions (30-year average) for the northern point within the CHP/Caltrans residential area.	Combination of annual average airborne dust (PM10) measurements from nearby desert location (Clark County, NV) (ENVIRON 2001) and constituent fractions in background (Younger Alluvium) soils.

Table 2-11
Oral Carcinogenic Slope Factors
Mountain Pass Mine

Chemical	Oral Slope Factor $(mg/kg/day)^{-1}$	Weight of Evidence	Tumor	Test Species	Slope Factor Source	Date
Metals						
Aluminum	-	-	-	-	1	-
Antimony (and compounds)	-	-	-	-	1	-
Arsenic	1.50E+00	A	Lung	Human	IRIS	Jul-99
Barium (and compounds)	-	-	-	-	1	-
Beryllium (and compounds)	-	-	-	-	2	-
Cadmium (and compounds)	-	B1	Not carcinogenic by this route	-	Cal EPA; 3	1994
Chromium (as III)	-	-	-	-	1	-
Chromium (as VI)	4.20E-01	A	-	Human	Cal EPA	1994, 1999
Cobalt	-	-	-	-	4	-
Copper (and compounds)	-	D	-	-	4	-
Lead (and compounds)	-	B2	Quantitative data insufficient to assess carcinogenic risk	Rat	IRIS; 4, 5	Jul-99
Manganese (and compounds)	-	D	-	-	4	-
Mercury (and compounds)	-	-	-	-	1	-
Molybdenum	-	-	-	-	1	-
Nickel (soluble salts)	-	A	Not carcinogenic by this route	-	Cal EPA; 3	1994
Selenium	-	-	-	-	1	-
Silver (and compounds)	-	-	-	-	1	-
Strontium, stable	-	-	-	-	6	-
Thallium (thallium carbonate)	-	-	-	-	1	-
Zinc (and compounds)	-	-	-	-	1	-
Lanthanides						
Lanthanides	-	-	-	-	7, 8	-
Other inorganics						
Uranium, soluble salts	-	-	-	-	6	-

Definitions:

A	- Chemical cancer classification (human carcinogen).
B1	- Chemical cancer classification (probable human carcinogen; limited human evidence).
B2	- Chemical cancer classification (probable human carcinogen; sufficient animal evidence and/or no human evidence).
D	- Chemical cancer classification (not classifiable as to carcinogenicity).
Cal EPA	- California Environmental Protection Agency.
IRIS	- Integrated Risk Information System.
$(mg/kg/day)^{-1}$	- Risk per milligram per kilogram per day.
PRG	- U. S. EPA, Region 9 Preliminary Remediation Goals (PRGs) (1998a).
SFs	- Slope Factors.

Notes:

1	- This chemical has not been demonstrated to be carcinogenic.
2	- Oral SF withdrawn by U.S. EPA and Cal EPA.
3	- Cadmium and nickel have not been demonstrated to be carcinogenic via the oral route of exposure.
4	- Quantitative data were insufficient for a carcinogenic risk assessment of this chemical (U.S. EPA 1999a).
5	- An oral SF for lead of 8.5E-3 has been developed by Cal EPA (1999); based on rat kidney tumor incidence data (Azar *et al.* , 1973) using a linearized multistage procedure. Based on recommendations from M. Schum (pers. comm.), carcinogenic risk estimates will be presented with and without contribution from exposures to lead.
6	- No data provided by Cal EPA (1994b, 1999), IRIS (U.S. EPA 1999a), HEAST (U.S. EPA 1997a), or PRG table (U.S. EPA 1998a).
7	- Lanthanides include cerium, dysprosium, erbium, europium, gadolinium, holmium, lanthanum, lutetium, neodymium, praseodymium, samarium, scandium, terbium, thulium, ytterbium and yttrium.
8	- Carcinogenicity has not been evaluated for this group of chemicals.

All weight of evidence classifications were obtained from U.S. EPA (1998b) Integrated Risk Information System (IRIS).

Table 2-12
Inhalation Carcinogenic Slope Factors
Mountain Pass Mine

Chemical	Inhalation Slope Factor (mg/kg/day)$^{-1}$	Weight of Evidence	Tumor	Test Species	Slope Factor Source	Date
Metals						
Aluminum	-	-	-	-	1	-
Antimony (and compounds)	-	-	-	-	1	-
Arsenic	1.20E+01	A	Lung	Human	Cal EPA; 2	1994, 1999
Barium (and compounds)	-	-	-	-	1	-
Beryllium (and compounds)	8.40E+00	-	-	-	Cal EPA; 2	1999
Cadmium (and compounds)	1.50E+01	B1	Lung, trachea, bronchus	Human	Cal EPA; 2	1994, 1999
Chromium (as III)	-	-	-	-	1	-
Chromium (as VI)	5.10E+02	A	Lung	Human	Cal EPA; 2	1994, 1999
Cobalt	-	-	-	-	3	-
Copper (and compounds)	-	D	-	-	1	-
Lead (and compounds)	-	B2	Quantitative data insufficient to assess carcinogenic risk	-	IRIS; 3; 4	Jul-99
Manganese (and compounds)	-	D	-	-	1	-
Mercury (and compounds)	-	-	-	-	1	-
Molybdenum	-	-	-	-	1	-
Nickel (soluble salts)	9.10E-01	A	Lung	Human	Cal EPA	1994, 1999
Selenium	-	-	-	-	1	-
Silver (and compounds)	-	-	-	-	1	-
Strontium, stable	-	-	-	-	1	-
Thallium (thallium carbonate)	-	-	-	-	1	-
Vanadium	-	-	-	-	1	-
Zinc (and compounds)	-	-	-	-	1	-
Lanthanides						
Lanthanides	-	-	-	-	1, 5	-
Other inorganics						
Chlorine[8]	-	-	-	-	6	-
Hydrochloric acid[8]	-	-	-	-	6	-
Phosphorus[8]	-	-	-	-	1	-
Sodium (sodium hydroxide)[8]	-	-	-	-	6	-
Uranium, soluble salts	-	-	-	-	6	-
Organics						
Acetaldehyde[8]	1.00E-02	B2	Nasal and Laryngeal	Hamster	Cal EPA	1994, 1999
Acrolein[8]	-	C	-	-	14	-
Benz(a)anthracene[8]	3.90E-01	B2	-	-	Cal EPA; 7	1994, 1999
Benzene[8]	1.00E-01	A	Leukemia	Human	Cal EPA	1994, 1999
Benzo(a)pyrene[8]	3.90E+00	B2	Respiratory tract	Hamster	Cal EPA	1994, 1999
Benzo(b)fluoranthene[8]	3.90E-01	B2	-	-	Cal EPA; 7	1994, 1999
Benzo(k)fluoranthene[8]	3.90E-01	B2	-	-	Cal EPA; 7	1994, 1999
1,3-Butadiene[8]	9.80E-01	B2	Lung	Mouse	IRIS; 2, 9	1999
Chrysene[8]	3.90E-02	B2	-	-	Cal EPA; 10	1994, 1999
Crotonaldehyde[8]	1.90E+00	C	Liver	Rat	HEAST; 11	Jul-97
Dibenz(a,h)anthracene[8]	4.10E+00	B2	Lung	Mouse	Cal EPA	1994, 1999
Ethylbenzene[8]	-	D	-	-	1	-
Formaldehyde[8]	2.10E-02	B1	Nasal	Rat	Cal EPA; 2	1994, 1999

Table 2-12
Inhalation Carcinogenic Slope Factors
Mountain Pass Mine

Chemical	Inhalation Slope Factor $(mg/kg/day)^{-1}$	Weight of Evidence	Tumor	Test Species	Slope Factor Source	Date
Indeno(1,2,3-c,d)pyrene[8]	3.90E-01	B2	-	-	Cal EPA; 7	1994, 1999
Naphthalene[8]	-	C	-	-	15	-
PAHs (total)[8]	3.90E+00	-	-	-	12	-
Proprionaldehyde[8]	-	-	-	-	13	-
Toluene[8]	-	D	-	-	1	-
Trimethylbenzene[8]	-	-	-	-	1	-
Xylenes[8]	-	D	-	-	1	-

Definitions:

A - Chemical cancer classification (human carcinogen).
B1 - Chemical cancer classification (probable human carcinogen; limited human evidence).
B2 - Chemical cancer classification (probable human carcinogen; sufficient animal evidence and/or no human evidence).
C - Chemical cancer classification (possible human carcinogen)
D - Chemical cancer classification (not classifiable as to human carcinogenicity).
Cal EPA - California Environmental Protection Agency.
COPC - Chemical of Potential Concern.
IRIS - Integrated Risk Information System.
$(mg/kg/day)^{-1}$ - Risk per milligram per kilogram per day.
PEF - Potency equivalency factor.
SF - Slope factor.
U.S. EPA - U.S. Environmental Protection Agency.

Notes:

1 - This chemical has not been demonstrated to be carcinogenic.

2 - Different cancer toxicity values for inhalation, expressed as unit risks, are also provided in IRIS (U.S. EPA July 1999) for the following chemicals:

Arsenic	4.3E-3 per mg/m^3
Beryllium	2.4E-3 per mg/m^3
Cadmium	1.8E+00 per mg/m^3
Chromium (VI)	1.2E-2 per mg/m^3

Cancer toxicity values for inhalation, expressed as unit risks, are also provided in IRIS (U.S. EPA March 2000) for the following chemicals:

Acetaldehyde	2.2E-6 per $\mu g/m^3$
1,3-Butadiene	2.8E-4 per $\mu g/m^3$
Formaldehyde	1.3E-5 per $\mu g/m^3$

3 - Quantitative data were insufficient for a carcinogenic risk assessment of this chemical (U.S. EPA 1999a).

4 - An inhalation SF for lead of 4.2E-2 is provided by Cal EPA (1999); based on rat kidney tumor incidence data (Azar *et al* ., 1973) using a linearized multistage procedure. Based on recommendations from M. Schum (pers. comm.), carcinogenic risk estimates will be presented with and without contribution from exposures to lead.

5 - Lanthanides include cerium, dysprosium, erbium, europium, gadolinium, holmium, lanthanum, lutetium, neodymium, praseodymium, samarium, scandium, terbium, thulium, ytterbium and yttrium.

6 - No data provided by Cal EPA (1994b, 1999), IRIS (U.S. EPA 1999a), HEAST (U.S. EPA 1997a) or PRG table (U.S. EPA 1998a).

7 - The SFs for this chemical were derived by multiplying the Cal EPA benzo(a)pyrene SFs by a Cal EPA (1994) PEF of 0.1.

8 - Chemical selected as COPC based on ENVIRON memo, *Selection of Chemicals of Potential Concern Based on Toxicity and Baseline Facilitiy Air Emissions* (March 8, 2000).

9 - Slope factor of 6E-1 per mg/kg/day given in Cal EPA (1999) for 1,3-butadiene.
IRIS (2000) slope factor of 9.8E-1 per mg/kg/day calculated from unit risk of 2.8E-4 per $\mu g/m^3$.

Table 2-12
Inhalation Carcinogenic Slope Factors
Mountain Pass Mine

Chemical	Inhalation Slope Factor (mg/kg/day)-1	Weight of Evidence	Tumor	Test Species	Slope Factor Source	Date

10 - The SFs for this chemical were derived by multiplying the Cal EPA benzo(a)pyrene SFs by a Cal EPA (1994) PEF of 0.01.
11 - A route-to-route extrapolation was performed; oral slope factor used for inhalation pathway.
12 - No toxicity data in U.S. EPA or Cal EPA databases. Benzo(a)pyrene data used as surrogate.
13 - Proprionaldehyde is not evaluated for carcinogenic risks (Response to comments from C.Lambert, Tetra Tech May 2000).
14 - Quantitative estimate of carcinogenic risk from inhalation exposure to acrolein is not available (IRIS, U.S. EPA March 2000).
15 - An inhalation unit risk for naphthalene was not derived because of the weakness of the evidence that naphthalene may be carcinogenic in humans (IRIS, U.S. EPA March 2000).

All weight of evidence classifications were obtained from U.S. EPA (1998b) Integrated Risk Information System (IRIS).

Table 2-13
Carcinogenic Slope Factors For Radionuclides
Mountain Pass Mine

Element	Isotope	Radioactive half-life	Oral Slope Factor (Risk/pCi)	Inhalation Slope Factor (Risk/pCi)	External Exposure Slope Factor (Risk/yr per pCi/g soil)
Actinium	Ac-228	6.13 hours	1.62E-12	3.27E-11	3.28E-06
Bismuth	Bi-210	5.01 days	7.29E-12	5.12E-11	0
	Bi-212	60.6 minutes	6.20E-13	3.65E-11	6.67E-07
	Bi-214	19.9 minutes	1.95E-13	1.46E-11	6.02E-06
Protactinium	Pa-234	6.7 hours	2.13E-12	1.30E-12	6.60E-06
Lead	Pb-210	22.3 years	6.75E-10	1.67E-09	1.12E-10
	Pb-210 +d	22.3 years	1.01E-09	3.86E-09	1.45E-10
	Pb-212	10.6 hours	1.80E-11	3.85E-11	3.00E-07
	Pb-214	26.8 minutes	2.94E-13	6.23E-12	7.09E-07
Polonium	Po-210	138 days	3.26E-10	2.14E-09	3.30E-11
	Po-212	2.98E-07 seconds	4.51E-23	5.93E-21	0
	Po-214	1.64E-04 seconds	2.12E-20	2.77E-18	3.23E-10
	Po-216	0.146 seconds	8.79E-17	2.95E-15	5.62E-11
	Po-218	3.05 minutes	5.08E-14	3.69E-12	0
Radium	Ra-224	3.62 days	1.49E-10	2.25E-09	2.48E-08
	Ra-226	1,600 years	2.95E-10	2.72E-09	1.31E-08
	Ra-226 +d	1,600 years	2.96E-10	2.75E-09	6.74E-06
	Ra-228	5.75 years	2.46E-10	9.61E-10	0
	Ra-228 +d	5.75 years	2.48E-10	9.94E-10	3.28E-06
Radon	Rn-220	55.6 seconds	-	1.92E-13	1.88E-09
	Rn-222 +d	3.82 days	-	7.57E-12	a
Thorium	Th-228	1.91 years	6.29E-11	9.45E-08	5.28E-10
	Th-228 +d	1.91 years	2.31E-10	9.68E-08	6.20E-06
	Th-230	77,000 years	3.75E-11	1.72E-08	4.40E-11
	Th-232	1.41E+10 years	3.28E-11	1.93E-08	1.97E-11
	Th-234	24.1 days	1.93E-11	1.90E-11	3.50E-09
Thallium	Tl-208	3.05 minutes	1.75E-14	1.36E-14	1.45E-05
Uranium	U-234	2.45E+05 years	4.44E-11	1.40E-08	2.14E-11
	U-235 +d	7.04E+08 years	4.70E-11	1.30E-08	2.65E-07
	U-238	4.47E+09 years	4.27E-11	1.24E-08	1.50E-11
	U-238 +d	4.47E+09 years	6.20E-11	1.24E-08	6.57E-08

Definitions:

Group A - Chemical cancer classification (human carcinogen).
pCi - picoCurie; one curie = 3.7×10^{10} nuclear transformations per second.
pCi/g - picoCurie per gram
+d - Plus daughters. This indicates that cancer risk estimates for these radionuclides include the contributions from their longer lived decay products, assuming equal activity concentrations (i.e., secular equilibrium) with the principal or parent nuclide in the environment.
yr - year.

Notes:

Weight of evidence assigned by U.S. EPA to all radionuclides is Group A.
a - External exposure slope factor for Rn-222 +d included with the Ra-226 +d external exposure slope factor.

Sources

Health Effects Assessment Summary Tables, July 1997.
Data from HEAST 1997 were updated with information at www.epa.gov/radiation/heast in July 1999.

Table 2-14
Chronic Oral Reference Doses
Mountain Pass Mine

Chemical		RfD (mg/kg/day)	Confidence	MF	UF	Critical Effect	Test Species	Source	Date
Metals									
Aluminum		1.0E+00	-	-	-	-	-	1	-
Antimony (and compounds)		4.0E-04	Low	1	1,000	Increased mortality, decreased blood glucose, altered cholesterol levels	Rat	IRIS	Jul-99
Arsenic		3.0E-04	Medium	1	3	Hyperpigmentation, keratosis, and possible vascular complications	Human	IRIS	Jul-99
Barium (and compounds)		7.0E-02	Medium	1	3	Increased blood pressure and kidney weights	Human and Rat	IRIS	Jul-99
Beryllium (and compounds)		2.0E-03	Low	1	300	Small intestinal lesions	Dog	IRIS	Jul-99
Boron		9.0E-02	Medium	1	100	Testicular atrophy, spermatogenic arrest	Dog	IRIS	Jul-99
Cadmium (and compounds)	in soil/food:	1.0E-03	High	1	10	Proteinuria	Human	IRIS; 7	Jul-99
	in water:	5.0E-04	High	1	10	Proteinuria	Human	IRIS; 7	Jul-99
Chromium (as III)		1.5E+00	Low	10	100	No effects observed	Rat	IRIS	Jul-99
Chromium (as VI)		3.0E-03	Low	3	300	No effects reported	Rat	IRIS	Jul-99
Cobalt		6.0E-02	-	-	-	-	-	2	-
Copper (and compounds)		3.7E-02	-	-	-	-	-	HEAST; 3	Jul-97
Lead (and compounds)		-	-	-	-	-	-	4	-
Manganese (and compounds)		1.4E-01	Medium	1	1	Central nervous system	Human	IRIS	Jul-99
Mercury (and compounds)		3.0E-04	High	1	1,000	Autoimmune effects	Rat	IRIS	Jul-99
Molybdenum		5.0E-03	Medium	1	30	Increased uric acid levels	Human	IRIS	Jul-99
Nickel (soluble salts)		2.0E-02	Medium	1	300	Decreased body and organ weights	Rat	IRIS	Jul-99
Selenium		5.0E-03	High	1	3	Clinical selenosis	Human	IRIS	Jul-99
Silver (and compounds)		5.0E-03	Low	1	3	Argyria	Human	IRIS	Jul-99
Strontium, stable		6.0E-01	Medium	1	300	Rachitic bone	Rat	IRIS	Jul-99
Thallium (thallium carbonate)		8.0E-05	Low	1	3000	Increased levels of SGOT and LDH	Rat	IRIS	Jul-99
Vanadium		7.0E-03	-	-	10	No critical effects observed	Rat	HEAST; 8	Jul-97
Zinc (and compounds)		3.0E-01	Medium	1	3	Decrease in erythrocyte superoxide dismutase (ESOD) concentration in adult females	Human	IRIS	Jul-99

Table 2-14
Chronic Oral Reference Doses
Mountain Pass Mine

Chemical	RfD (mg/kg/day)	Confidence	MF	UF	Critical Effect	Test Species	Source	Date
Lanthanides								
Lanthanides	5.0E-03	-	1	3000	Decrease in body weight	Rat	TERA; 5, 6	Nov-99
Other inorganics								
Uranium, soluble salts	3.0E-03	Medium	1	1000	Body weight loss, nephrotoxicity	Rabbits	IRIS	Jul-99
Organics								
Nitrate	1.6E+00	High	1	1	Early clinical signs of methemoglobinemia	Human	IRIS	Jul-99

Definitions:

ATSDR - Agency for Toxic Substances and Disease Registry, MRLs (provided as Health Guidelines and Comparison Values, Department of Health and Human Services).
DTSC - Department of Toxic Substances Control.
HEAST - Health Effects Assessment Summary Tables.
IRIS - Integrated Risk Information System.
MF - Modifying factor.
mg/kg/day - Milligrams per kilogram per day.
MRL - Minimal Risk Level.
RfD - Reference dose.
TERA - Toxicology Excellence for Risk Assessment.
UF - Uncertainty factor.

Notes:

1 - U. S. EPA, Region 9 Preliminary Remediation Goals (PRGs) (1998a).
2 - U. S. EPA, Region 9 Preliminary Remediation Goals (PRGs) (1998a). Withdrawn.
3 - Based on drinking water criterion of 1 mg/L.
4 - Lead is evaluated using the DTSC lead spreadsheet.
5 - Lanthanides include cerium, dysprosium, erbium, europium, gadolinium, holmium, lanthanum, lutetium, neodymium, praseodymium, samarium, scandium, terbium, thulium, ytterbium and yttrium.
6 - Based on TWG consensus, the RfD developed for lanthanum chloride (TERA 1999) will be used as surrogate toxicity data for oral exposures for all lanthanides.
7 - An RfD of 2E-4 has also been provided as a chronic oral MRL in ATSDR (1999) for cadmium.
8 - An RfD of 3E-3 mg/kg/day has also been provided as an intermediate oral MRL in ATSDR (1999) for vanadium.

Table 2-15
Chronic Inhalation Reference Doses
Mountain Pass Mine

Chemical	RfD (mg/kg/day)	RfC (mg/m^3)	Confidence	MF	UF	Critical Effect	Test Species	Source	Date
Metals									
Aluminum	1.0E+00	-	-	-	-	-	-	1	-
Antimony (and compounds)	4.0E-04	-	-	-	-	-	-	1	-
Arsenic	3.0E-04	-	-	-	-	-	-	1	-
Barium (and compounds)	7.0E-02	-	-	-	-	-	-	1	-
Beryllium (and compounds)	5.7E-06	2.0E-05	Medium	1	10	Chronic beryllium disease	Human	IRIS; 12, 14	Jul-99
Cadmium (and compounds)	5.7E-05	-	-	-	-	-	-	2	-
Chromium (as III)	1.5E+00	-	-	-	-	-	-	1	-
Chromium (as VI) (aerosol)	2.3E-06	8.0E-06	Low	1	90	Nasal septum atrophy	Human	IRIS; 12, 14	Jul-99
Cobalt	5.7E-06	-	-	-	-	-	-	2	-
Copper (and compounds)	3.7E-02	-	-	-	-	-	-	1	-
Lead (and compounds)	-	-	-	-	-	-	-	3	-
Manganese (and compounds)	1.4E-05	5.0E-05	Medium	1	1000	Impaired neurobehavioral function	Human	IRIS; 12, 14	Jul-99
Mercury (and compounds)	3.0E-04	-	-	-	-	-	-	1	-
Molybdenum	5.0E-03	-	-	-	-	-	-	1	-
Nickel (soluble salts)	2.0E-02	-	-	-	-	-	-	1	-
Selenium	5.0E-03	-	-	-	-	-	-	1	-
Silver (and compounds)	5.0E-03	-	-	-	-	-	-	1	-
Strontium, stable	6.0E-01	-	-	-	-	-	-	1	-
Thallium (thallium carbonate)	8.0E-05	-	-	-	-	-	-	2	-
Vanadium	7.0E-03	-	-	-	-	-	-	HEAST	Jul-97
Zinc (and compounds)	3.0E-01	-	-	-	-	-	-	1	-
Lanthanides									
Lanthanides	8.6E-05	3.0E-04	-	1	3000	Bronchial lymph node hyperplasia	Rat	4, 5, 12	-
Other inorganics									
Chlorine[8]	5.7E-05	2.0E-04	-	-	-	Effects on respiratory system	-	Cal EPA; 9, 12	Feb-00
Hydrochloric acid (hydrogen chloride)[8]	2.0E-03	7.0E-03	-	-	-	-	-	CAPCOA; 12	1993
Phosphorus (white)[8]	2.0E-05	7.0E-05	-	-	-	-	-	CAPCOA; 12	1993
Sodium (sodium hydroxide)[8]	1.4E-03	4.8E-03	-	-	-	-	-	CAPCOA; 12	1993
Uranium, soluble salts	3.0E-03	-	-	-	-	-	-	1	-

Table 2-15
Chronic Inhalation Reference Doses
Mountain Pass Mine

Chemical	RfD (mg/kg/day)	RfC (mg/m^3)	Confidence	MF	UF	Critical Effect	Test Species	Source	Date
Organics									
Acetaldehyde[8]	2.6E-03	9.0E-03	Low	1	1000	Degeneration of olfactory epithelium	Rat	IRIS; 10	Mar-00
Acrolein[8]	5.7E-06	2.0E-05	Medium	1	1000	Squamous metaplasia and neutrophilic infiltration of nasal epithelium	Rat	IRIS; 10	Mar-00
Benz(a)anthracene[8]	8.6E-04	-	-	-	-	-	-	11	-
Benzene[8]	1.7E-03	6.0E-02	-	-	-	Effects on hematopoietic system, development, nervous system, immune system	Human	Cal EPA; 9, 10	Feb-00
Benzo(a)pyrene[8]	8.6E-04	-	-	-	-	-	-	11	-
Benzo(b)fluoranthene[8]	8.6E-04	-	-	-	-	-	-	11	-
Benzo(k)fluoranthene[8]	8.6E-04	-	-	-	-	-	-	11	-
1,3-Butadiene[8]	-	-	-	-	-	-	-	6	-
Chrysene[8]	8.6E-04	-	-	-	-	-	-	11	-
Crotonaldehyde[8]	1.0E-02	-	-	-	-	-	-	1, 2	-
Dibenz(a,h)anthracene[8]	8.6E-04	-	-	-	-	-	-	11	-
Ethylbenzene[8]	2.9E-01	1.0E+00	Low	1	300	Developmental toxicity	Rat and rabbit	IRIS; 7	Mar-00
Formaldehyde[8]	8.6E-04	3.0E-03	-	-	-	Effects on respiratory system, eyes	Human	Cal EPA; 9, 12	Feb-00
Indeno(1,2,3-c,d)pyrene[8]	8.6E-04	-	-	-	-	-	-	11	-
Naphthalene[8]	8.6E-04	3.0E-03	Medium	1	3000	Hyperplasia and metaplasia in respiratory and olfactory epthelia, respectively	Mouse	IRIS; 12	Mar-00
PAHs (total)[8]	8.6E-04	-	-	-	-	-	-	11	-
Proprionaldehyde[8]	2.6E-03	9.0E-03	-	-	-	-	-	13	-
Toluene[8]	1.1E-01	4.0E-01	Medium	1	300	Neurological effects and degeneration of nasal epithelium	Human and rat	IRIS; 12	Mar-00
Trimethylbenzene[8]	1.7E-03	-	-	-	-	-	-	2	1998
Xylenes[8]	2.0E+00	-	-	-	-	-	-	1	-

Definitions:

ATSDR - Agency for Toxic Substances and Disease Registry, MRLs (provided as Health Guidelines and Comparison Values, Department of Health and Human Services).
Cal EPA - Califonia Environmental Protection Agency.
CAPCOA - California Air Pollution Control Officers Association.
COPC - Chemical of Potential Concern.
DTSC - Department of Toxic Substances Control.
HEAST - Health Effects Assessment Summary Tables.
IRIS - Integrated Risk Information System.
MF - Modifying factor.
mg/kg/day - Milligrams per kilogram per day.
mg/m^3 - Milligrams per cubic meter.
MRL - Minimal Risk Level.

Table 2-15
Chronic Inhalation Reference Doses
Mountain Pass Mine

Chemical	RfD (mg/kg/day)	RfC (mg/m³)	Confidence	MF	UF	Critical Effect	Test Species	Source	Date

REL - Reference Exposure Level.
RfC - Reference concentration.
RfD - Reference dose.
TERA - Toxicology Excellence for Risk Assessment.
UF - Uncertainty factor.

Notes:

1 - A route-to-route extrapolation was performed, the oral RfD was applied for the inhalation route of exposure.
2 - U. S. EPA, Region 9 Preliminary Remediation Goals (PRGs) (1998a).
3 - Lead is evaluated using the DTSC lead spreadsheet.
4 - Lanthanides include cerium, dysprosium, erbium, europium, gadolinium, holmium, lanthanum, lutetium, neodymium, praseodymium, samarium, scandium, terbium, thulium, ytterbium and yttrium.
5 - Based on TWG consensus, the RfC developed for ceric oxide (TERA 1999) will be used as surrogate toxicity data for inhalation exposures for all lanthanides.
6 - No RfDs developed by IRIS (U.S. EPA 1998b), ATSDRs (1999), HEAST (U.S. EPA 1997a), or U.S. EPA (PRGs) (1998a). Chronic RELs not adopted by Cal EPA (Feb 2000).
7 - REL also adopted by Cal EPA (Feb 2000) for ethylbenzene: 2E+0 mg/m^3, or 6E-1 mg/kg/day. Effects on development, alimentary system (liver), kidney, and endocrine system.
8 - Chemical selected as COPC based on ENVIRON memo, *Selection of Chemicals of Potential Concern Based on Toxicity and Baseline Facilitity Air Emissions* (March 8, 2000).
9 - Chronic Reference Exposure Level adopted by Cal EPA (Feb 2000) (converted from µg/m^3 to mg/m^3)
10 - RfD provided by U.S. EPA PRGs (1998a).
11 - No RfD data in U.S. EPA or Cal EPA databases. Naphthalene data used as surrogate.
12 - Inhalation RfDs given as RfCs are converted to RfDs for humans using the equation: (RfC/1)(20m^3/day)(1/70kg).
13 - No RfD data in U.S. EPA or Cal EPA databases. Acetaldehyde data used as surrogate for noncarcinogenic effects only.
14 - ATSDR chronic inhalation MRLs for Manganese, Mercury, and Nickel are 1.1E-5, 5.7E-5, and 5.7E-5 mg/kg/day, respectively.

Table 2-16
Cancer Risk Estimates for the Day Visitor,
Baseline Scenario
Mountain Pass Mine

	Risk Probability				
	Soil[1]		Air		
Carcinogen	**Ingestion**	**Dermal contact**	**Inhalation**	**Summation**	**% Contribution**
Metals					
Arsenic	-	-	5.2E-10	5.2E-10	38.6%
Beryllium	-	-	9.4E-11	9.4E-11	7.0%
Cadmium	-	-	1.5E-10	1.5E-10	10.8%
Chromium (VI)	-	-	8.6E-11	8.6E-11	6.4%
Nickel	-	-	4.7E-11	4.7E-11	3.5%
Organics					
1,3-Butadiene	-	-	2.9E-12	2.9E-12	0.2%
Acetaldehyde	-	-	4.7E-12	4.7E-12	0.3%
Benzene	-	-	3.2E-11	3.2E-11	2.4%
Benzo(a)anthracene	-	-	1.1E-15	1.1E-15	0.0%
Benzo(a)pyrene	-	-	5.9E-15	5.9E-15	0.0%
Benzo(b)fluoranthene	-	-	5.2E-16	5.2E-16	0.0%
Benzo(k)fluoranthene	-	-	6.5E-15	6.5E-15	0.0%
Chrysene	-	-	1.0E-16	1.0E-16	0.0%
Crotonaldehyde	-	-	3.8E-10	3.8E-10	28.5%
Dibenz(a,h)anthracene	-	-	5.3E-15	5.3E-15	0.0%
Formaldehyde	-	-	3.1E-11	3.1E-11	2.3%
Indeno(1,2,3-c,d)pyrene	-	-	5.1E-16	5.1E-16	0.0%
PAH (Total)	-	-	1.5E-14	1.5E-14	0.0%
Summation	-	-	1.3E-09	1.3E-09	

1 - No carcinogenic COPCs identified in soil

BOLD = carcinogenic risk probability greater than 1 x 10^{-6}

Table 2-17
Cancer Risk Estimates for the Day Visitor
Reference Scenario
Mountain Pass Mine

	Risk probability				
	Soil[1]		Air		
Carcinogen	**Ingestion**	**Dermal contact**	**Inhalation**	**Summation**	**% Contribution**
Metals					
Arsenic	-	-	3.E-09	3.E-09	78.5%
Beryllium	-	-	2.E-10	2.E-10	4.9%
Cadmium	-	-	7.E-11	7.E-11	2.1%
Nickel	-	-	5.E-10	5.E-10	14.5%
Summation	-	-	4.E-09	4.E-09	

Key:

1 - No carcinogenic COPCs identified in soil

BOLD = carcinogenic risk probability greater than 1 x 10^{-6}

Table 2-18
Noncancer Risk Estimates for the Day Visitor,
Baseline Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)			
	Soil		Air	
Noncarcinogen	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals				
Aluminum	-	-	3.E-08	
Antimony	-	-	5.E-07	
Arsenic	-	-	2.E-06	
Barium	0.0018	3.E-05	4.E-06	
Beryllium	4.E-05	8.E-07	2.E-05	
Cadmium	3.E-05	5.E-08	2.E-06	
Chromium	2.E-06	3.E-08	-	
Chromium (VI)	-	-	8.E-07	
Cobalt	1.E-05	2.E-07	-	
Copper	3.E-05	5.E-07	-	
Manganese	0.0002	3.E-06	0.0014	
Mercury	-	-	6.E-08	
Molybdenum	9.E-06	2.E-07	-	
Nickel	0.0001	2.E-06	3.E-08	
Selenium	6.E-06	1.E-07	-	
Silver	3.E-06	4.E-08	-	
Strontium	8.E-05	1.E-06	-	
Thallium	0.0002	4.E-06	-	
Vanadium	0.0004	7.E-06	-	
Zinc	2.E-05	4.E-07	-	
Lanthanides				
Lanthanides	0.003	0.0009	0.0248	
Other Inorganics				
Chlorine	-	-	0.0002	
Hydrochloric Acid	-	-	3.E-05	
Phosphorus	-	-	7.E-07	
Sodium	-	-	2.E-08	
Organics				
Acetaldehyde	-	-	2.E-06	
Acrolein	-	-	0.0001	
Benzene	-	-	2.E-06	
Benzo(a)anthracene	-	-	3.E-11	
Benzo(a)pyrene	-	-	2.E-11	
Benzo(b)fluoranthene	-	-	2.E-11	
Benzo(k)fluoranthene	-	-	2.E-10	
Chrysene	-	-	3.E-11	
Crotonaldehyde	-	-	2.E-07	
Dibenz(a,h)anthracene	-	-	2.E-11	
Ethylbenzene	-	-	7.E-10	
Formaldehyde[1]	-	-	2.E-05	
Indeno(1,2,3-c,d)pyrene	-	-	2.E-11	
Naphthalene	-	-	1.E-06	
o-Xylene	-	-	5.E-10	
PAH (Total)	-	-	5.E-11	
Proprionaldehyde	-	-	1.E-06	
Toluene[1]	-	-	4.E-08	
Trimethylbenzene	-	-	7.E-07	
Uranium	3.E-05	5.E-07	-	
Xylenes	-	-	5.E-10	
Hazard Index (HI) by Health Effect*				**Summation**
Respiratory	-	-	0.0252	0.03
Other	0.006	0.001	0.001	0.008

Key:

1 - For inhalation pathway, chemical has known respiratory effects as well as other effects (see Table 2-14), and is therefore summed in both health effects categories.

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-19
Noncancer Risk Estimates for the Day Visitor
Reference Scenario (Younger Alluvium Soils)
Mountain Pass Mine

	Hazard Quotient (HQ)			
	Soil		Air	
Noncarcinogen	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals				
Aluminum	-	-	5.E-06	
Antimony	-	-	2.E-07	
Arsenic	-	-	8.E-06	
Barium	0.0004	7.E-06	2.E-06	
Beryllium	2.E-05	4.E-07	4.E-05	
Cadmium	1.E-05	2.E-08	9.E-07	
Chromium	7.E-07	1.E-08	-	
Cobalt	8.E-06	1.E-07	-	
Copper	3.E-05	4.E-07	-	
Manganese	0.0001	3.E-06	0.0076	
Mercury	-	-	4.E-08	
Molybdenum	7.E-06	1.E-07	-	
Nickel	6.E-05	1.E-06	3.E-07	
Selenium	4.E-06	7.E-08	-	
Silver	1.E-06	2.E-08	-	
Strontium	2.E-05	3.E-07	-	
Thallium	0.0002	3.E-06	-	
Vanadium	0.0003	5.E-06	-	
Zinc	1.E-05	2.E-07	-	
Lanthanide Metals				
Lanthanides	0.0006	0.0002	0.0030	
Actinide metals				
Uranium	2.E-05	3.E-07	-	
Hazard Index (HI) by Health Effect*				**Summation**
Respiratory	-	-	0.0031	0.0031
Other	0.002	0.0002	0.0077	0.010

Key:

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-20
Noncancer Risk Estimates for the Day Visitor
Reference Scenario
(Older Alluvium Soils)
Mountain Pass Mine

	Hazard Quotient (HQ)			
	Soil		Air	
Noncarcinogen	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals				
Aluminum	-	-	5.E-06	
Antimony	-	-	2.E-07	
Arsenic	-	-	8.E-06	
Barium	0.0022	4.E-05	2.E-06	
Beryllium	3.E-05	4.E-07	4.E-05	
Cadmium	2.E-05	4.E-08	9.E-07	
Chromium	2.E-03	6.E-04	-	
Cobalt	8.E-07	1.E-08	-	
Copper	9.E-06	2.E-07	-	
Manganese	3.02E-05	5.E-07	0.0076	
Mercury	-	-	4.E-08	
Molybdenum	6.E-06	1.E-07	-	
Nickel	5.E-05	8.E-07	3.E-07	
Selenium	7.E-06	1.E-07	-	
Silver	1.E-06	2.E-08	-	
Strontium	0.0001	2.E-06	-	
Thallium	0.0002	4.E-06	-	
Vanadium	0.0003	5.E-06	-	
Zinc	2.E-05	4.E-07	-	
Lanthanide Metals				
Lanthanides	0.0038	0.0011	0.0030	
Actinide metals				
Uranium	3.E-05	5.E-07	-	
Hazard Index (HI) by Health Effect*				**Summation**
Respiratory	-	-	0.0031	0.003
Other	0.009	0.002	0.0077	0.02

Key:

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-21
Critical Effects and Toxic Endpoints
Inhalation Exposure Route
Mountain Pass Mine

COPC	Alimentary	Bone	Blood	CNS	Developmental	Endocrine	Eye	Heart/Cardiovascular	Immune	Kidney	Liver	Reproductive	Respiratory	Skin/hair/nails	Weight loss	Notes
	Critical effect/Toxic endpoint															
Metals/Inorganics																
Aluminum																1
Antimony			I													2
Arsenic								I						I		2
Barium										I						2
Beryllium													I			
Cadmium										I						2
Chlorine													O			
Chromium (as III)																1
Chromium (as VI)													I			
Cobalt																1
Copper																1
HCl													I			
Lanthanides													T			
Manganese				I												
Mercury (as mercuric chloride)									I							2
Molybdenum										I						2
Nickel															I	2
Phosphorus (white)												I		I		2
Selenium														I		2
Silver														I		2
Sodium (hydroxide)																1
Strontium		I														2
Thallium (as thallium chloride)			I													2
Uranium, soluble salts										I					I	2
Vanadium																1
Zinc			I													2
Organics																
Acetaldehyde													I			
Acrolein													I			
Benzene			O	O	O				O							
Benzo(a)anthracene													I			3
Benzo(a)pyrene													I			3
Benzo(b)fluoranthene													I			3
Benzo(k)fluoranthene													I			3
Chrysene													I			3
Crotonaldehyde																1
Dibenz(a,h)anthracene													I			3
Ethylbenzene					I											
Formaldehyde							O						O			
Indeno(1,2,3-cd)pyrene													I			3
Naphthalene													I			
PAH (Total)													I			3
Proprionaldehyde													I			4
Toluene				I									I			
Trimethylbenzene																1
Xylene															I	2

Key:

- I - U. S. EPA IRIS critical effect
- O - California Office of Environmental Health and Hazard Assessment (OEHHA) (2000) Chronic Reference Exposure Limits (RELs)
- T - TERA

Notes:

1 - No effects given
2 - route-to-route extrapolation
3 - naphthalene used as a surrogate
4 - acetaldehyde used as a surrogate

Table 2-22
Critical Effects and Toxic Endpoints
Ingestion Exposure Route
Mountain Pass Mine

	Critical effect/Toxic endpoint															
COPC	Alimentary	Bone	Blood	CNS	Developmental	Endocrine	Eye	Heart/Cardiovascular	Immune	Kidney	Liver	Reproductive	Respiratory	Skin/hair/nails	Weight loss	Notes
Metals																
Aluminum																1
Antimony			I													
Arsenic								I						I		
Barium			I							I						
Beryllium	I															
Boron												I				
Cadmium										I						
Chromium (as III)																1
Chromium (as VI)																1
Cobalt																1
Copper																1
Lanthanides															T	
Manganese				I												
Mercury (as mercuric chloride)									I							
Molybdenum										I						
Nickel															I	
Nitrate			I													
Selenium														I		
Silver														I		
Strontium		I														
Thallium (as thallium chloride)			I													
Uranium, soluble salts										I					I	
Vanadium																1
Zinc			I													

Key:

I - U. S. EPA IRIS critical effect
T - TERA

Notes:

1 - No effects given

Table 2-23
Predicted Blood Lead Levels (µg/dL)
Mountain Pass Mine

Receptor	Scenario	Lead Concentration in Soil (mg/kg)	Lead Concentration in Groundwater (µg/L)	Lead Concentration in Air ($\mu g/m^3$)	Predicted Blood Lead Level (µg/dL) 95th percentile	99th percentile
Day Visitor						
	Baseline	108	(1)	0.0018	**2.5**	**3.5**
	Future	114	(1)	0.0016	**2.5**	**3.5**
	Reference	24	(1)	3.2E-07	**2.4**	**3.3**
Offsite Resident						
Young Child						
	Baseline	59	(1)	0.0073	**4.4**	**6.1**
	Future	77	(1)	0.0056	**4.8**	**6.6**
	Reference	24	(1)	3.2E-07	**3.7**	**5.1**
School-age Child						
	Baseline	84	(1)	0.0064	**4.9**	**6.8**
	Future	100	(1)	0.0050	**5.2**	**7.2**
	Reference	24	(1)	3.2E-07	**3.7**	**5.1**
Older Child/Adult						
	Baseline	49	(1)	0.0073	**2.5**	**3.4**
	Future	62	(1)	0.0056	**2.5**	**3.5**
	Reference	24	(1)	3.2E-07	**2.4**	**3.3**
School Child						
	Baseline	57	(1)	0.0011	**4.4**	**6.0**
	Future	59	(1)	0.0014	**4.4**	**6.1**
	Reference	24	(1)	3.2E-07	**3.7**	**5.1**

Definitions:

µg/dL - Micrograms per deciliter.
µg/L - Micrograms per liter.
µg/m3 - Micrograms per cubic meter.
mg/kg - Milligrams per kilogram.
RME - Reasonable maximum exposure.

Notes:

(1) - Default (DTSC 1992, 2000) lead concentration for drinking water (15 µg/L) used in calculations.

Table 2-24
Estimated Cancer Risks from Radioistopes
Mountain Pass Mine

		Soil		Carpet Dust		Inhalation	
Receptor	**Scenario**	**Ingestion**	**Direct Irradiation**	**Ingestion**	**Direct Irradiation**		**Summation**
Visitor							
	Baseline	4.2E-08	9.4E-06	-	-	2.4E-10	9.5E-06
	Future	4.2E-08	9.4E-06	-	-	1.2E-10	9.5E-06
	Reference	2.7E-08	5.1E-06	-	-	6.6E-11	5.1E-06
School child							
	Baseline	2.6E-08	6.4E-06	1.1E-07	9.2E-06	5.4E-11	1.6E-05
	Future	2.6E-08	6.4E-06	1.2E-07	9.7E-06	3.6E-11	1.6E-05
	Reference	2.1E-08	4.0E-06	1.5E-07	1.5E-05	2.8E-11	1.9E-05
Offsite Resident							
	Baseline	2.1E-07	1.6E-05	3.7E-07	1.4E-04	5.6E-09	1.5E-04
	Future	2.1E-07	1.6E-05	3.3E-07	1.3E-04	3.3E-09	1.5E-04
	Reference	4.2E-07	4.9E-05	5.7E-07	2.8E-04	7.6E-10	3.3E-04

Table 2-25
Cancer Risk Estimates for the Day Visitor, Future Scenario
Mountain Pass Mine

	Risk Probability				
	Soil[1]		Air		
Carcinogen	**Baseline**	**Incremental Future**	**Inhalation**	**Summation**	**% Contribution**
Metals					
Arsenic	-	1.9E-10	4.8E-10	6.6E-10	1.8%
Beryllium	-	-	1.1E-10	1.1E-10	0.3%
Cadmium	-	-	5.1E-10	5.1E-10	1.4%
Chromium (VI)	-	7.4E-12	2.3E-09	2.3E-09	6.2%
Nickel	-	-	8.0E-11	8.0E-11	0.2%
Organics					
1,3-Butadiene	-	-	1.3E-08	1.3E-08	34.8%
Acetaldehyde	-	-	2.1E-10	2.1E-10	0.6%
Benzene	-	-	1.3E-09	1.3E-09	3.4%
Benzo(a)anthracene	-	-	9.3E-16	9.3E-16	0.0%
Benzo(a)pyrene	-	-	5.2E-15	5.2E-15	0.0%
Benzo(b)fluoranthene	-	-	4.6E-16	4.6E-16	0.0%
Benzo(k)fluoranthene	-	-	5.7E-15	5.7E-15	0.0%
Chrysene	-	-	8.8E-17	8.8E-17	0.0%
Crotonaldehyde	-	-	1.8E-08	1.8E-08	47.6%
Dibenz(a,h)anthracene	-	-	4.7E-15	4.7E-15	0.0%
Formaldehyde	-	-	1.3E-09	1.3E-09	3.6%
Indeno(1,2,3-c,d)pyrene	-	-	4.5E-16	4.5E-16	0.0%
PAH (Total)	-	-	1.4E-14	1.4E-14	0.0%
Summation	-	1.9E-10	3.7E-08	3.7E-08	

Key:

1 - Baseline and Incremental Future risk probabilities include incidental soil ingestion and dermal contact with soil.

BOLD = carcinogenic risk probability greater than 1 x 10^{-6}

Table 2-26
Noncancer Risk Estimates for the Day Visitor, Future Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)			
	Soil[1]		Air	
Noncarcinogen	**Baseline**	**Incremental Future**	**Inhalation**	
Metals				
Aluminum	-	7.E-07	9.E-08	
Antimony	-	9.E-06	2.E-06	
Arsenic	-	4.E-06	1.E-06	
Barium	0.0019	3.E-05	3.E-06	
Beryllium	4.E-05	7.E-07	2.E-05	
Cadmium	3.E-05	2.E-06	6.E-06	
Chromium	2.E-06	-	-	
Chromium (VI)	-	6.E-08	2.E-05	
Cobalt	1.E-05	-	-	
Copper	3.E-05	-	-	
Manganese	0.0002	2.E-06	0.0043	
Mercury	-	3.E-06	5.E-07	
Molybdenum	9.E-06	-	-	
Nickel	0.0001	4.E-07	5.E-08	
Selenium	6.E-06	-	-	
Silver	3.E-06	-	-	
Strontium	0.0001	-	-	
Thallium	0.0002	-	-	
Vanadium	0.0004	-	-	
Zinc	2.E-05	-	-	
Lanthanides				
Lanthanides	0.0039	0.0004	0.0333	
Other Inorganics				
Chlorine	-	-	0.0002	
Hydrochloric Acid	-	-	3.E-05	
Phosphorus	-	-	3.E-05	
Sodium	-	-	1.E-06	
Organics				
Acetaldehyde	-	-	9.E-05	
Acrolein	-	-	0.0001	
Benzene	-	-	8.E-05	
Benzo(a)anthracene	-	-	3.E-11	
Benzo(a)pyrene	-	-	2.E-11	
Benzo(b)fluoranthene	-	-	1.E-11	
Benzo(k)fluoranthene	-	-	2.E-10	
Chrysene	-	-	3.E-11	
Crotonaldehyde	-	-	1.E-05	
Dibenz(a,h)anthracene	-	-	1.E-11	
Ethylbenzene	-	-	2.E-08	
Formaldehyde[2]	-	-	0.0008	
Indeno(1,2,3-c,d)pyrene	-	-	1.E-11	
Naphthalene	-	-	6.E-06	
o-Xylene	-	-	2.E-08	
PAH (Total)	-	-	5.E-11	
Toluene[2]	-	-	1.E-06	
Trimethylbenzene	-	-	3.E-05	
Xylenes	-	-	1.E-08	
Hazard Index (HI) by Health Effect*				**Summation**
Respiratory	-	-	0.0346	0.03
Other	0.007	0.0004	0.005	0.01

Key:

1 - Baseline and Incremental Future Soil HQs include ingestion and dermal contact; hazard indices (HIs) for future soil contact are the sum of baseline and incremental future HQs.

2 - For inhalation pathway, chemical has known respiratory effects as well as other effects (see Table 2-21), and is therefore summed in both health effects categories.

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-27
Cancer Risk Estimates for the School Child, Baseline Scenario
Mountain Pass Mine

	Risk Probability						
	Soil[1]		Indoor Carpet Dust		Air		
Carcinogen	**Ingestion**	**Dermal contact**	**Ingestion**	**Dermal contact**	**Inhalation**	**Summation**	**% Contribution**
Metals							
Arsenic	-	-	5.5E-08	8.1E-08	4.0E-10	1.4E-07	99.0%
Beryllium	-	-	-	-	5.9E-11	5.9E-11	0.0%
Cadmium	-	-	-	-	1.9E-10	1.9E-10	0.1%
Chromium (VI)	-	-	-	-	3.0E-10	3.0E-10	0.2%
Nickel	-	-	-	-	3.7E-11	3.7E-11	0.0%
Organics							
1,3-Butadiene	-	-	-	-	5.0E-11	5.0E-11	0.0%
Acetaldehyde	-	-	-	-	8.2E-12	8.2E-12	0.0%
Benzene	-	-	-	-	5.4E-11	5.4E-11	0.0%
Benzo(a)anthracene	-	-	-	-	1.8E-14	1.8E-14	0.0%
Benzo(a)pyrene	-	-	-	-	1.0E-13	1.0E-13	0.0%
Benzo(b)fluoranthene	-	-	-	-	8.9E-15	8.9E-15	0.0%
Benzo(k)fluoranthene	-	-	-	-	1.1E-13	1.1E-13	0.0%
Chrysene	-	-	-	-	1.7E-15	1.7E-15	0.0%
Crotonaldehyde	-	-	-	-	6.7E-10	6.7E-10	0.5%
Dibenz(a,h)anthracene	-	-	-	-	9.1E-14	9.1E-14	0.0%
Formaldehyde	-	-	-	-	7.7E-11	7.7E-11	0.1%
Indeno(1,2,3-c,d)pyrene	-	-	-	-	8.8E-15	8.8E-15	0.0%
PAH (Total)	-	-	-	-	7.5E-14	7.5E-14	0.0%
Summation	-	-	5.5E-08	8.1E-08	1.8E-09	1.4E-07	

1 - No carcinogenic COPCs identified in soil

BOLD = carcinogenic risk probability greater than 1×10^{-6}

Table 2-28
Cancer Risk Estimates for the School Child
Reference Scenario
Mountain Pass Mine

	Risk Probability						
	Soil[1]		Indoor Carpet Dust		Air		
Carcinogen	**Ingestion**	**Dermal contact**	**Ingestion**	**Dermal contact**	**Inhalation**	**Summation**	**% Contribution**
Metals							
Arsenic	-	-	6.E-08	9.E-08	4.E-09	2.E-07	99.8%
Beryllium	-	-	-	-	3.E-10	3.E-10	0.2%
Cadmium	-	-	-	-	1.E-10	1.E-10	0.1%
Nickel	-	-	-	-	7.E-10	7.E-10	0.5%
Summation	-	-	6.E-08	9.E-08	5.E-09	2.E-07	

Key:

1 - No carcinogenic COPCs identified in soil

BOLD = carcinogenic risk probability greater than 1 x 10^{-6}

Table 2-29
Noncancer Risk Estimates for the School Child, Baseline Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil		Carpet Dust		Air	
Noncarcinogen	**Ingestion**	**Dermal contact**	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals						
Aluminum	-	-	0.0015	0.0002	5.E-08	
Antimony	-	-	-	-	5.E-07	
Arsenic	-	-	0.0017	0.0025	2.E-06	
Barium	0.0055	0.0008	0.0045	0.0006	3.E-06	
Beryllium	-	-	-	-	2.E-05	
Cadmium	8.E-05	1.E-06	0.0017	2.E-05	3.E-06	
Chromium	-	-	6.E-06	8.E-07	-	
Chromium (VI)	-	-	-	-	4.E-06	
Cobalt	-	-	2.E-05	3.E-06	-	
Copper	-	-	0.0006	8.E-05	-	
Manganese	-	-	-	-	0.0018	
Mercury	-	-	0.0003	4.E-05	4.E-07	
Nickel	-	-	0.0004	5.E-05	3.E-08	
Selenium	9.E-06	1.E-06	-	-	-	
Strontium	0.0003	4.E-05	0.0009	0.0001	-	
Thallium	0.0004	5.E-05	-	-	-	
Vanadium	-	-	0.0008	0.0001	-	
Zinc	0.0002	3.E-05	0.0010	0.0001	-	
Lanthanides						
Lanthanides	0.0048	0.0109	0.0288	0.0657	0.0457	
Other Inorganics						
Chlorine	-	-	-	-	0.0019	
Hydrochloric Acid	-	-	-	-	0.0002	
Phosphorus	-	-	-	-	2.E-06	
Sodium	-	-	-	-	5.E-08	
Organics						
Acetaldehyde	-	-	-	-	4.E-06	
Acrolein	-	-	-	-	0.0030	
Benzene	-	-	-	-	4.E-06	
Benzo(a)anthracene	-	-	-	-	8.E-10	
Benzo(a)pyrene	-	-	-	-	4.E-10	
Benzo(b)fluoranthene	-	-	-	-	4.E-10	
Benzo(k)fluoranthene	-	-	-	-	5.E-09	
Chrysene	-	-	-	-	7.E-10	
Crotonaldehyde	-	-	-	-	5.E-07	
Dibenz(a,h)anthracene	-	-	-	-	4.E-10	
Ethylbenzene	-	-	-	-	2.E-09	
Formaldehyde[1]	-	-	-	-	6.E-05	
Indeno(1,2,3-c,d)pyrene	-	-	-	-	4.E-10	
Naphthalene	-	-	-	-	2.E-05	
o-Xylene	-	-	-	-	1.E-09	
PAH (Total)	-	-	-	-	3.E-10	
Proprionaldehyde	-	-	-	-	3.E-06	
Toluene[1]	-	-	-	-	9.E-08	
Trimethylbenzene	-	-	-	-	1.E-06	
Uranium	-	-	0.0003	4.E-05	-	
Xylenes	-	-	-	-	1.E-09	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	0.0509	0.05
Other	0.011	0.012	0.042	0.070	0.002	0.14

Key:

1 - For inhalation pathway, chemical has known respiratory effects as well as other effects (see Table 2-21), and is therefore summed in both health effects categories.

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-30
Noncancer Risk Estimates for the School Child
Reference Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil		Carpet Dust		Air	
Noncarcinogen	**Ingestion**	**Dermal contact**	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals						
Aluminum	-	-	0.0038	0.0005	9.E-06	
Antimony	-	-	-	-	4.E-07	
Arsenic	-	-	0.0019	0.0027	2.E-05	
Barium	0.0009	0.0001	0.0017	0.0002	4.E-06	
Beryllium	-	-	-	-	7.E-05	
Cadmium	2.E-05	3.E-07	4.E-05	6.E-07	2.E-06	
Chromium	-	-	3.E-06	4.E-07	-	
Cobalt	-	-	3.E-05	5.E-06	-	
Copper	-	-	0.0001	2.E-05	-	
Manganese	-	-	-	-	0.014	
Mercury	-	-	3.E-05	5.E-06	8.E-08	
Nickel	-	-	0.0002	3.E-05	6.E-07	
Selenium	9.E-06	1.E-06	-	-	-	
Strontium	5.E-05	6.E-06	0.0001	1.E-05	-	
Thallium	0.0005	6.E-05	-	-	-	
Vanadium	-	-	0.0012	0.0002	-	
Zinc	3.E-05	4.E-06	0.0001	7.E-06	-	
Lanthanide Metals						
Lanthanides	0.0014	0.0032	0.0025	0.0057	0.0057	
Actinide metals						
Uranium	-	-	0.0001	1.E-05	-	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	0.0058	0.0058
Other	0.003	0.003	0.012	0.009	1.E-02	0.04

Key:

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-31
Cancer Risk Estimates for the School Child, Future Scenario
Mountain Pass Mine

	Risk Probability						
	Soil[1]		Indoor Carpet Dust		Air		
Carcinogen	**Baseline**	**Incremental Future**	**Ingestion**	**Dermal contact**	**Inhalation**	**Summation**	**% Contribution**
Metals							
Arsenic	-	6.8E-10	5.6E-08	8.2E-08	4.3E-10	1.4E-07	82.2%
Beryllium	-	-	-	-	8.8E-11	8.8E-11	0.1%
Cadmium	-	-	-	-	7.0E-10	7.0E-10	0.4%
Chromium (VI)	-	1.6E-11	2.8E-11		3.0E-09	3.0E-09	1.8%
Nickel	-	-	-	-	6.2E-11	6.2E-11	0.0%
Organics							
1,3-Butadiene	-	-	-	-	3.3E-11	3.3E-11	0.0%
Acetaldehyde	-	-	-	-	2.7E-10	2.7E-10	0.2%
Benzene	-	-	-	-	1.6E-09	1.6E-09	1.0%
Benzo(a)anthracene	-	-	-	-	1.2E-14	1.2E-14	0.0%
Benzo(a)pyrene	-	-	-	-	6.7E-14	6.7E-14	0.0%
Benzo(b)fluoranthene	-	-	-	-	5.9E-15	5.9E-15	0.0%
Benzo(k)fluoranthene	-	-	-	-	7.3E-14	7.3E-14	0.0%
Chrysene	-	-	-	-	1.1E-15	1.1E-15	0.0%
Crotonaldehyde	-	-	-	-	2.3E-08	2.3E-08	13.4%
Dibenz(a,h)anthracene	-	-	-	-	6.0E-14	6.0E-14	0.0%
Formaldehyde	-	-	-	-	1.7E-09	1.7E-09	1.0%
Indeno(1,2,3-c,d)pyrene	-	-	-	-	5.8E-15	5.8E-15	0.0%
PAH (Total)	-	-	-	-	7.3E-14	7.3E-14	0.0%
Summation	-	7.0E-10	5.6E-08	8.2E-08	3.0E-08	1.7E-07	

Key:

1 - Baseline and Incremental Future risk probabilities include incidental soil ingestion and dermal contact with soil.

BOLD = carcinogenic risk probability greater than 1×10^{-6}

Table 2-32
Noncancer Risk Estimates for the School Child, Future Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil[1]		Carpet Dust		Air	
Noncarcinogen	**Baseline**	**Incremental Future**	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals						
Aluminum	-	2.E-06	0.0015	0.0002	1.E-07	
Antimony	-	2.E-05	-	-	3.E-06	
Arsenic	-	2.E-05	0.0017	0.0025	2.E-06	
Barium	0.0062	7.E-05	0.0045	0.0006	4.E-06	
Beryllium	-	2.E-06	-	-	3.E-05	
Cadmium	0.0001	5.E-06	0.0019	3.E-05	1.E-05	
Chromium	-	-	6.E-06	8.E-07	-	
Chromium (VI)	-	2.E-07	3.E-07	-	4.E-05	
Cobalt	-	-	2.E-05	3.E-06	-	
Copper	-	-	0.0006	8.E-05	-	
Manganese	-	4.E-06	-	-	0.0062	
Mercury	-	1.E-05	0.0005	7.E-05	1.E-06	
Nickel	-	1.E-06	0.0004	5.E-05	5.E-08	
Selenium	0.0000	-	-	-	-	
Strontium	0.0003	-	0.0009	0.0001	-	
Thallium	0.0004	-	-	-	-	
Vanadium	-	-	0.0008	0.0001	-	
Zinc	0.0002	-	0.0010	0.0001	-	
Lanthanides						
Lanthanides	0.0156	0.0017	0.0336	0.0766	0.0572	
Other Inorganics						
Chlorine	-	-	-	-	0.0019	
Hydrochloric Acid	-	-	-	-	0.0002	
Phosphorus	-	-	-	-	5.E-05	
Sodium	-	-	-	-	2.E-06	
Organics	-	-				
Acetaldehyde	-	-	-	-	0.0001	
Acrolein	-	-	-	-	0.0020	
Benzene	-	-	-	-	0.0001	
Benzo(a)anthracene	-	-	-	-	5.E-10	
Benzo(a)pyrene	-	-	-	-	3.E-10	
Benzo(b)fluoranthene	-	-	-	-	2.E-10	
Benzo(k)fluoranthene	-	-	-	-	3.E-09	
Chrysene	-	-	-	-	5.E-10	
Crotonaldehyde	-	-	-	-	2.E-05	
Dibenz(a,h)anthracene	-	-	-	-	2.E-10	
Ethylbenzene	-	-	-	-	3.E-08	
Formaldehyde[2]	-	-	-	-	0.0013	
Indeno(1,2,3-c,d)pyrene	-	-	-	-	2.E-10	
Naphthalene	-	-	-	-	2.E-05	
o-Xylene	-	-	-	-	4.E-08	
PAH (Total)	-	-	-	-	3.E-10	
Proprionaldehyde	-	-	-	-	9.E-05	
Toluene[2]	-	-	-	-	2.E-06	
Trimethylbenzene	-	-	-	-	4.E-05	
Uranium	-	-	0.0003	4.E-05	-	
Xylenes	-	-	-	-	2.E-08	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	0.0629	0.06
Other	0.023	0.002	0.048	0.081	0.008	0.16

Key:

1 - Baseline and Incremental Future hazard quotients (HQs) include incidental soil ingestion and dermal contact with soil. Hazard indices (HIs) for future soil contact are the sum of baseline and incremental future HQs.

2 - For inhalation pathway, chemical has known respiratory effects as well as other effects (see Table 2-21), and is therefore summed in both health effects categories.

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-33
Cancer Risk Estimates for the Offsite Resident, Baseline Scenario
Mountain Pass Mine

	Risk Probability						
	Soil[1]		Indoor Carpet Dust		Air		
Carcinogen	**Ingestion**	**Dermal contact**	**Ingestion**	**Dermal contact**	**Inhalation**	**Summation**	**% Contribution**
Metals							
Arsenic	-	-	4.9E-07	4.7E-07	6.5E-08	**1.0E-06**	50.7%
Beryllium	-	-	-	-	1.1E-08	1.1E-08	0.6%
Cadmium	-	-	-	-	5.0E-08	5.0E-08	2.5%
Chromium (VI)	-	-	-	-	1.5E-07	1.5E-07	7.2%
Nickel	-	-	-	-	1.0E-08	1.0E-08	0.5%
Organics							
1,3-Butadiene	-	-	-	-	1.4E-08	1.4E-08	0.7%
Acetaldehyde	-	-	-	-	8.0E-09	8.0E-09	0.4%
Benzene	-	-	-	-	4.9E-08	4.9E-08	2.4%
Benzo(a)anthracene	-	-	-	-	5.1E-12	5.1E-12	0.0%
Benzo(a)pyrene	-	-	-	-	2.9E-11	2.9E-11	0.0%
Benzo(b)fluoranthene	-	-	-	-	2.5E-12	2.5E-12	0.0%
Benzo(k)fluoranthene	-	-	-	-	3.2E-11	3.2E-11	0.0%
Chrysene	-	-	-	-	4.9E-13	4.9E-13	0.0%
Crotonaldehyde	-	-	-	-	6.5E-07	6.5E-07	32.2%
Dibenz(a,h)anthracene	-	-	-	-	2.6E-11	2.6E-11	0.0%
Formaldehyde	-	-	-	-	5.7E-08	5.7E-08	2.8%
Indeno(1,2,3-c,d)pyrene	-	-	-	-	2.5E-12	2.5E-12	0.0%
PAH (Total)	-	-	-	-	1.1E-11	1.1E-11	0.0%
Summation	-	-	4.9E-07	4.7E-07	**1.1E-06**	**2.0E-06**	

1 - No carcinogenic COPCs identified in soil

BOLD = carcinogenic risk probability greater than 1×10^{-6}

Table 2-34
Cancer Risk Estimates for the Offsite Resident
Reference Scenario
Mountain Pass Mine

	Risk probability						
	Soil[1]		Indoor Carpet Dust		Air		
Carcinogen	**Ingestion**	**Dermal contact**	**Ingestion**	**Dermal contact**	**Inhalation**	**Summation**	**% Contribution**
Metals							
Arsenic	-	-	6.E-07	6.E-07	8.E-08	**1.E-06**	98.4%
Beryllium	-	-	-	-	5.E-09	5.E-09	0.4%
Cadmium	-	-	-	-	2.E-09	2.E-09	0.2%
Nickel	-	-	-	-	1.E-08	1.E-08	1.1%
Summation	-	-	6.E-07	6.E-07	1.E-07	**1.E-06**	

Key:

1 - No carcinogenic COPCs identified in soil

BOLD = carcinogenic risk probability greater than 1 x 10^{-6}

Table 2-35
Noncancer Risk Estimates for the Young Child Offsite Resident,
Baseline Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil		Indoor Carpet Dust		Air	
Noncarcinogen	Ingestion	Dermal contact	Ingestion	Dermal contact	Inhalation	
Metals						
Aluminum	-	-	0.0196	0.0010	3.E-06	
Antimony	-	-	-	-	0.0001	
Arsenic	-	-	0.0185	0.0097	0.0002	
Barium	0.0623	0.0031	0.0253	0.0013	0.0004	
Beryllium	-	-	-	-	0.0025	
Cadmium	0.0006	3.E-06	0.0074	4.E-05	0.0006	
Chromium	-	-	5.E-05	2.E-06	-	
Chromium (VI)	-	-	-	-	0.0013	
Cobalt	-	-	0.0002	9.E-06	-	
Copper	-	-	0.0053	0.0003	-	
Manganese	-	-	-	-	0.2470	
Mercury	-	-	0.0034	0.0002	0.0001	
Molybdenum	0.0008	4.E-05	-	-	-	
Nickel	-	-	0.0032	0.0002	6.0E-06	
Silver	0.0001	4.E-06	-	-	-	
Strontium	0.0022	0.0001	0.0045	0.0002	-	
Vanadium	-	-	0.0062	0.0003	-	
Zinc	0.0001	4.E-06	0.0040	0.0002	-	
Lanthanides						
Lanthanides	-	-	0.1075	0.0882	**2.490**	
Other Inorganics						
Chlorine	-	-	-	-	0.5380	
Hydrochloric Acid	-	-	-	-	0.0441	
Phosphorus	-	-	-	-	0.0011	
Sodium	-	-	-	-	4.0E-05	
Organics						
Acetaldehyde	-	-	-	-	0.0033	
Acrolein	-	-	-	-	0.6410	
Benzene	-	-	-	-	0.0031	
Benzo(a)anthracene	-	-	-	-	2.E-07	
Benzo(a)pyrene	-	-	-	-	9.E-08	
Benzo(b)fluoranthene	-	-	-	-	8.E-08	
Benzo(k)fluoranthene	-	-	-	-	1.E-06	
Chrysene	-	-	-	-	2.E-07	
Crotonaldehyde	-	-	-	-	0.0004	
Dibenz(a,h)anthracene	-	-	-	-	8.E-08	
Ethylbenzene	-	-	-	-	8.E-07	
Formaldehyde[1]	-	-	-	-	0.0337	
Indeno(1,2,3-c,d)pyrene	-	-	-	-	8.0E-08	
Naphthalene	-	-	-	-	0.0046	
o-Xylene	-	-	-	-	8.9E-07	
PAH (Total)	-	-	-	-	3.4E-08	
Proprionaldehyde	-	-	-	-	0.0020	
Toluene[1]	-	-	-	-	0.0001	
Trimethylbenzene	-	-	-	-	0.0010	
Uranium	-	-	0.0021	0.0001	-	
Xylenes	-	-	-	-	5.E-07	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	**3.8**	**3.8**
Other	0.068	0.003	0.207	0.102	0.3	0.7

Key:

1 - For inhalation pathway, chemical has known respiratory effects as well as other effects (see Table 2-21), and is therefore summed in both health effects categories.

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-36
Noncancer Risk Estimates for the Young Child Offsite Resident
Reference Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil		Indoor Carpet Dust		Air	
Noncarcinogen	**Ingestion**	**Dermal contact**	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals						
Aluminum	-	-	0.0483	0.0024	0.0001	
Antimony	-	-	-	-	6.E-06	
Arsenic	-	-	0.0238	0.0125	0.0002	
Barium	0.0215	0.0011	0.0215	0.0011	0.0001	
Beryllium	-	-	-	-	0.0011	
Cadmium	0.0005	3.E-06	0.0005	3.E-06	3.E-05	
Chromium	-	-	4.E-05	2.E-06	-	
Cobalt	-	-	0.0004	2.E-05	-	
Copper	-	-	0.0014	0.0001	-	
Manganese	-	-	-	-	0.2090	
Mercury	-	-	0.0004	2.E-05	1.E-06	
Molybdenum	0.0004	2.E-05	-	-		
Nickel	-	-	0.0031	0.0002	8.E-06	
Silver	0.0001	3.E-06	-	-	-	
Strontium	0.0011	0.0001	0.0011	0.0001	-	
Vanadium	-	-	0.0154	0.0008	-	
Zinc	0.0006	3.E-05	0.0006	3.E-05	-	
Lanthanide Metals						
Lanthanides	-	-	0.0317	0.0260	0.083	
Actinide metals						
Uranium	-	-	0.0010	0.0001	-	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	0.084	0.084
Other	0.024	0.001	0.149	0.043	0.21	0.4

Key:

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-37
Noncancer Risk Estimates for the School Age Offsite Resident,
Baseline Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil		Carpet Dust		Air	
Noncarcinogen	**Ingestion**	**Dermal contact**	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals						
Aluminum	-	-	0.0061	0.0008	1.E-06	
Antimony	-	-	-	-	4.E-05	
Arsenic	-	-	0.0061	0.0089	8.E-05	
Barium	0.0222	0.0031	0.0104	0.0014	0.0002	
Beryllium	-	-	-	-	0.0011	
Cadmium	0.0002	3.E-06	0.0034	5.E-05	0.0003	
Chromium	-	-	2.E-05	2.E-06	-	
Chromium (VI)	-	-	-	-	0.0006	
Cobalt	-	-	6.E-05	9.E-06	-	
Copper	-	-	0.0018	0.0002	-	
Manganese	-	-	-	-	0.1060	
Mercury	-	-	0.0011	0.0001	4.E-05	
Molybdenum	0.0002	3.E-05	-	-	-	
Nickel	-	-	0.0011	0.0002	3.E-06	
Silver	2.E-05	3.E-06	-	-	-	
Selenium	9.E-06	1.E-06	-	-	-	
Strontium	0.0009	0.0001	0.0020	0.0003	-	
Thallium	0.0004	5.E-05	-	-	-	
Vanadium	-	-	0.0022	0.0003	-	
Zinc	0.0005	7.E-05	0.0020	0.0003	-	
Lanthanides						
Lanthanides	0.0048	0.0109	0.054	0.123	**1.1**	
Other Inorganics						
Chlorine	-	-	-	-	0.2282	
Hydrochloric Acid	-	-	-	-	0.0188	
Phosphorus	-	-	-	-	0.0005	
Sodium	-	-	-	-	2.E-05	
Organics						
Acetaldehyde	-	-	-	-	0.0014	
Acrolein	-	-	-	-	0.2731	
Benzene	-	-	-	-	0.0013	
Benzo(a)anthracene	-	-	-	-	7.E-08	
Benzo(a)pyrene	-	-	-	-	4.E-08	
Benzo(b)fluoranthene	-	-	-	-	3.E-08	
Benzo(k)fluoranthene	-	-	-	-	4.E-07	
Chrysene	-	-	-	-	7.E-08	
Crotonaldehyde	-	-	-	-	0.0002	
Dibenz(a,h)anthracene	-	-	-	-	3.E-08	
Ethylbenzene	-	-	-	-	3.47E-07	
Formaldehyde[1]	-	-	-	-	0.0142	
Indeno(1,2,3-c,d)pyrene	-	-	-	-	3.E-08	
Naphthalene	-	-	-	-	0.0020	
o-Xylene	-	-	-	-	4.E-07	
PAH (Total)	-	-	-	-	1.E-08	
Proprionaldehyde	-	-	-	-	0.0008	
Toluene[1]	-	-	-	-	2.E-05	
Trimethylbenzene	-	-	-	-	0.0004	
Uranium	-	-	0.0008	0.0001	-	
Xylenes	-	-	-	-	2.E-07	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	**1.6**	**1.6**
Other	0.029	0.014	0.091	0.136	0.1	0.4

Key:

1 - For inhalation pathway, chemical has known respiratory effects as well as other effects (see Table 2-21), and is therefore summed in both health effects categories.

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-38
Noncancer Risk Estimates for the School Age Offsite Resident
Reference Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil		Carpet Dust		Air	
Noncarcinogen	**Ingestion**	**Dermal contact**	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals						
Aluminum	-	-	0.0151	0.0053	5.45E-05	
Antimony	-	-	-	-	2.56E-06	
Arsenic	-	-	0.0075	0.0101	0.0001	
Barium	0.0067	0.0009	0.0067	0.0024	2.43E-05	
Beryllium	-	-	-	-	0.0005	
Cadmium	0.0002	2.E-06	0.0002	4.E-05	1.06E-05	
Chromium	-	-	1.E-05	4.E-06	-	
Cobalt	-	-	1.E-04	5.E-05	-	
Copper	-	-	0.0004	0.0002	-	
Manganese	-	-	-	-	0.0882	
Mercury	-	-	0.0001	5.E-05	4.99E-07	
Molybdenum	0.0001	1.33E-05	-	-	-	
Nickel	-	-	0.0010	0.0003	3.50E-06	
Selenium	9.E-06	1.E-06	-	-	-	
Silver	2.E-05	2.E-06	-	-	-	
Strontium	0.0003	0.00005	0.0003	0.0001	-	
Thallium	0.0005	6.E-05	-	-	-	
Vanadium	-	-	0.0048	0.0017	-	
Zinc	0.0002	3.E-05	0.0002	0.0001	-	
Lanthanide Metals						
Lanthanides	0.0014	0.0032	0.00992	0.01946	0.0347	
Actinide metals						
Uranium	-	-	0.0003	0.0001	-	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	0.0351	0.0351
Other	0.009	0.004	0.047	0.040	9.E-02	0.2

Key:

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-39
Noncancer Risk Estimates for the Adult Offsite Resident,
Baseline Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil		Carpet Dust		Air	
Noncarcinogen	**Ingestion**	**Dermal contact**	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals						
Aluminum	-	-	0.0013	0.0001	8.E-07	
Antimony	-	-	-	-	3.E-05	
Arsenic	-	-	0.0012	0.0011	6.E-05	
Barium	0.0064	0.0005	0.0017	0.0001	0.0001	
Beryllium	-	-	-	-	0.0008	
Cadmium	6.E-05	5.E-07	0.0005	4.E-06	0.0002	
Chromium	-	-	3.E-06	3.E-07	-	
Chromium (VI)	-	-	-	-	0.0004	
Cobalt	-	-	1.E-05	1.E-06	-	
Copper	-	-	0.0003	3.E-05	-	
Manganese	-	-	-	-	0.0756	
Mercury	-	-	0.0002	2.E-05	3.E-05	
Molybdenum	8.E-05	7.E-06	-	-	-	
Nickel	-	-	0.0002	2.E-05	2.E-06	
Silver	8.E-06	7.E-07	-	-	-	
Strontium	0.0002	2.E-05	0.0003	3.E-05	-	
Vanadium	-	-	0.0004	3.E-05	-	
Zinc	0.0001	9.E-06	0.0003	2.E-05	-	
Lanthanides						
Lanthanides	-	-	0.0071	0.0100	0.7620	
Other Inorganics						
Chlorine	-	-	-	-	0.1650	
Hydrochloric Acid	-	-	-	-	0.0135	
Phosphorus	-	-	-	-	0.0004	
Sodium	-	-	-	-	1.E-05	
Organics						
Acetaldehyde	-	-	-	-	0.0010	
Acrolein	-	-	-	-	0.1960	
Benzene	-	-	-	-	0.0009	
Benzo(a)anthracene	-	-	-	-	5.E-08	
Benzo(a)pyrene	-	-	-	-	3.E-08	
Benzo(b)fluoranthene	-	-	-	-	2.E-08	
Benzo(k)fluoranthene	-	-	-	-	3.E-07	
Chrysene	-	-	-	-	5.E-08	
Crotonaldehyde	-	-	-	-	0.0001	
Dibenz(a,h)anthracene	-	-	-	-	2.E-08	
Ethylbenzene	-	-	-	-	3.E-07	
Formaldehyde[1]	-	-	-	-	0.0103	
Indeno(1,2,3-c,d)pyrene	-	-	-	-	2.E-08	
Naphthalene	-	-	-	-	0.0014	
o-Xylene	-	-	-	-	3.E-07	
PAH (Total)	-	-	-	-	1.E-08	
Proprionaldehyde	-	-	-	-	0.0006	
Toluene[1]	-	-	-	-	2.E-05	
Trimethylbenzene	-	-	-	-	0.0003	
Uranium	-	-	0.0001	1.E-05	-	
Xylenes	-	-	-	-	2.E-07	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	**1.2**	**1.2**
Other	0.007	0.001	0.014	0.012	0.1	0.1

Key:

1 - For inhalation pathway, chemical has known respiratory effects as well as other effects (see Table2-21), and is therefore summed in both health effects categories.

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-40
Noncancer Risk Estimates for the Adult Offsite Resident
Reference Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil		Carpet Dust		Air	
Noncarcinogen	**Ingestion**	**Dermal contact**	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals						
Aluminum	-	-	0.0032	0.0003	3.97E-05	
Antimony	-	-	-	-	1.86E-06	
Arsenic	-	-	0.0016	0.0014	6.99E-05	
Barium	0.0022	0.0002	0.0014	0.0001	1.77E-05	
Beryllium	-	-	-	-	0.0003	
Cadmium	5.E-05	5.E-07	4.E-05	3.E-07	7.71E-06	
Chromium	-	-	2.E-06	2.E-07	-	
Cobalt	-	-	3.E-05	2.E-06	-	
Copper	-	-	0.0001	8.E-06	-	
Manganese	-	-	-	-	0.0641	
Mercury	-	-	3.E-05	2.E-06	3.63E-07	
Molybdenum	4.E-05	3.E-06	-	-		
Nickel	-	-	0.0002	1.73E-05	2.55E-06	
Silver	7.E-06	6.E-07	-	-	-	
Strontium	0.0001	9.E-06	0.0001	6.E-06	-	
Vanadium	-	-	0.0010	9.E-05	-	
Zinc	0.0001	6.E-06	4.E-05	4.E-06	-	
Lanthanide Metals						
Lanthanides	-	-	0.0021	0.0029	0.0255	
Actinide metals						
Uranium	-	-	0.0001	6.E-06	-	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	0.0258	0.0258
Other	0.002	0.0002	0.010	0.005	6.E-02	0.08

Key:

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-41
Cancer Risk Estimates for the Offsite Resident,
Future Scenario
Mountain Pass Mine

	Risk Probability						
	Soil[1]		Indoor Carpet Dust		Air		
Carcinogen	**Baseline**	**Incremental Future**	**Ingestion**	**Dermal contact**	**Inhalation**	**Summation**	**% Contribution**
Metals							
Arsenic	-	1.9E-08	5.1E-07	4.8E-07	6.6E-08	**1.1E-06**	44.6%
Beryllium	-	-	-	-	1.5E-08	1.5E-08	0.6%
Cadmium	-	-	-	-	5.0E-08	5.0E-08	2.1%
Chromium (VI)	-	4.1E-10	3.8E-10	-	1.7E-07	1.7E-07	7.3%
Nickel	-	-	-	-	1.4E-08	1.4E-08	0.6%
Organics							
1,3-Butadiene	-	-	-	-	1.3E-08	1.3E-08	0.5%
Acetaldehyde	-	-	-	-	1.1E-08	1.1E-08	0.5%
Benzene	-	-	-	-	6.6E-08	6.6E-08	2.8%
Benzo(a)anthracene	-	-	-	-	4.6E-12	4.6E-12	0.0%
Benzo(a)pyrene	-	-	-	-	2.6E-11	2.6E-11	0.0%
Benzo(b)fluoranthene	-	-	-	-	2.3E-12	2.3E-12	0.0%
Benzo(k)fluoranthene	-	-	-	-	2.8E-11	2.8E-11	0.0%
Chrysene	-	-	-	-	4.4E-13	4.4E-13	0.0%
Crotonaldehyde	-	-	-	-	9.1E-07	9.1E-07	37.9%
Dibenz(a,h)anthracene	-	-	-	-	2.3E-11	2.3E-11	0.0%
Formaldehyde	-	-	-	-	7.6E-08	7.6E-08	3.2%
Indeno(1,2,3-c,d)pyrene	-	-	-	-	2.3E-12	2.3E-12	0.0%
PAH (Total)	-	-	-	-	1.0E-11	1.0E-11	0.0%
Summation	-	2.0E-08	5.1E-07	4.8E-07	**1.4E-06**	**2.4E-06**	

Key:

1 - Baseline and Incremental Future risk probabilities include incidental soil ingestion and dermal contact with soil.

BOLD = carcinogenic risk probability greater than 1 x 10^{-6}

Table 2-42
Noncancer Risk Estimates for the Young Child Offsite Resident,
Future Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil[1]		Carpet Dust		Air	
Noncarcinogen	**Baseline**	**Incremental Future**	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals						
Aluminum	-	4.E-05	0.0196	0.0010	3.E-06	
Antimony	-	0.0005	-	-	0.0001	
Arsenic	-	0.0006	0.0189	0.0100	0.0002	
Barium	0.0654	0.0028	0.0270	0.0013	0.0004	
Beryllium	-	7.E-05	-	-	0.0033	
Cadmium	0.0006	0.0002	0.0104	5.E-05	0.0006	
Chromium	-	-	5.E-05	2.E-06	-	
Chromium (VI)	-	5.E-06	5.E-06	-	0.0016	
Cobalt	-	-	0.0002	9.E-06	-	
Copper	-	-	0.0053	0.0003	-	
Manganese	-	0.0002	-	-	0.2890	
Mercury	-	0.0006	0.0088	0.0004	9.E-05	
Molybdenum	0.0008	-	-	-	-	
Nickel	-	6.E-05	0.0032	0.0002	8.E-06	
Silver	8.45E-05	-	-	-	-	
Strontium	0.0023	-	0.0045	0.0002	-	
Vanadium	-	-	0.0062	0.0003	-	
Zinc	0.0001	-	0.0040	0.0002	-	
Lanthanides						
Lanthanides	-	0.0331	0.2020	0.1650	**2.8**	
Other Inorganics						
Chlorine	-	-	-	-	0.5220	
Hydrochloric Acid	-	-	-	-	0.0427	
Phosphorus	-	-	-	-	0.0016	
Sodium	-	-	-	-	5.E-05	
Organics						
Acetaldehyde	-	-	-	-	0.0044	
Acrolein	-	-	-	-	0.5750	
Benzene	-	-	-	-	0.0041	
Benzo(a)anthracene	-	-	-	-	1.E-07	
Benzo(a)pyrene	-	-	-	-	8.E-08	
Benzo(b)fluoranthene	-	-	-	-	7.E-08	
Benzo(k)fluoranthene	-	-	-	-	9.E-07	
Chrysene	-	-	-	-	1.E-07	
Crotonaldehyde	-	-	-	-	5.E-04	
Dibenz(a,h)anthracene	-	-	-	-	7.E-08	
Ethylbenzene	-	-	-	-	1.E-06	
Formaldehyde[2]	-	-	-	-	0.0437	
Indeno(1,2,3-c,d)pyrene	-	-	-	-	7.E-08	
Naphthalene	-	-	-	-	0.0043	
o-Xylene	-	-	-	-	1.E-06	
PAH (Total)	-	-	-	-	3.E-08	
Proprionaldehyde	-	-	-	-	0.0027	
Toluene[2]	-	-	-	-	7.E-05	
Trimethylbenzene	-	-	-	-	0.0013	
Uranium	-	-	0.0021	0.0001	-	
Xylenes	-	-	-	-	6.E-07	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	**4.0**	**4.0**
Other	0.069	0.038	0.312	0.179	0.3	0.9

Key:

1 - Baseline and Incremental Future hazard quotients (HQs) include incidental soil ingestion and dermal contact with soil. Hazard indices (HIs) for future soil contact are the sum of baseline and incremental future HQs.

2 - For inhalation pathway, chemical has known respiratory effects as well as other effects (see Table2-21), and is therefore summed in both health effects categories.

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-43
Noncancer Risk Estimates for the School Age Offsite Resident,
Future Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil[1]		Carpet Dust		Air	
Noncarcinogen	**Baseline**	**Incremental Future**	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals						
Aluminum	-	1.E-05	0.0061	0.0008	1.E-06	
Antimony	-	0.0002	-	-	5.E-05	
Arsenic	-	0.0003	0.0062	0.0090	8.E-05	
Barium	0.0253	0.0009	0.0109	0.0015	0.0002	
Beryllium	-	2.E-05	-	-	0.0014	
Cadmium	0.0003	5.E-05	0.0043	6.E-05	0.0003	
Chromium	-	-	2.E-05	2.E-06	-	
Chromium (VI)	-	2.E-06	2.E-06	-	0.0007	
Cobalt	-	-	6.E-05	9.E-06	-	
Copper	-	-	0.0018	0.0002	-	
Manganese	-	6.E-05	-	-	0.1283	
Mercury	-	0.0002	0.0026	0.0004	4.E-05	
Molybdenum	0.0002	-	-	-	-	
Nickel	-	2.E-05	0.0011	0.0002	4.E-06	
Silver	2.E-05	-	-	-	-	
Selenium	1.E-05	-	-	-	-	
Strontium	0.0010	-	0.0020	0.0003	-	
Thallium	0.0004	-	-	-	-	
Vanadium	-	-	0.0022	0.0003	-	
Zinc	0.0005	-	0.0020	0.0003	-	
Lanthanides						
Lanthanides	0.0156	0.0178	0.0810	0.1848	**1.3**	
Other Inorganics						
Chlorine	-	-	-	-	0.2212	
Hydrochloric Acid	-	-	-	-	0.0182	
Phosphorus	-	-	-	-	0.0007	
Sodium	-	-	-	-	2.E-05	
Organics						
Acetaldehyde	-	-	-	-	0.0020	
Acrolein	-	-	-	-	0.2441	
Benzene	-	-	-	-	0.0018	
Benzo(a)anthracene	-	-	-	-	6.E-08	
Benzo(a)pyrene	-	-	-	-	3.E-08	
Benzo(b)fluoranthene	-	-	-	-	3.E-08	
Benzo(k)fluoranthene	-	-	-	-	4.E-07	
Chrysene	-	-	-	-	6.E-08	
Crotonaldehyde	-	-	-	-	0.0002	
Dibenz(a,h)anthracene	-	-	-	-	3.E-08	
Ethylbenzene	-	-	-	-	4.E-07	
Formaldehyde[2]	-	-	-	-	0.0197	
Indeno(1,2,3-c,d)pyrene	-	-	-	-	3.E-08	
Naphthalene	-	-	-	-	0.0018	
o-Xylene	-	-	-	-	6.E-07	
PAH (Total)	-	-	-	-	1.E-08	
Proprionaldehyde	-	-	-	-	0.0012	
Toluene[2]	-	-	-	-	3.E-05	
Trimethylbenzene	-	-	-	-	0.0006	
Uranium	-	-	0.0008	0.0001	-	
Xylenes	-	-	-	-	3.E-07	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	**1.8**	**1.8**
Other	0.043	0.019	0.121	0.198	0.2	0.5

Key:

1 - Baseline and Incremental Future hazard quotients (HQs) include incidental soil ingestion and dermal contact with soil. Hazard indices (HIs) for future soil contact are the sum of baseline and incremental future HQs.

2 - For inhalation pathway, chemical has known respiratory effects as well as other effects (see Table 2-21), and is therefore summed in both health effects categories.

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

Table 2-44
Noncancer Risk Estimates for the Adult Offsite Resident,
Future Scenario
Mountain Pass Mine

	Hazard Quotient (HQ)					
	Soil[1]		Carpet Dust		Air	
Noncarcinogen	**Baseline**	**Incremental Future**	**Ingestion**	**Dermal contact**	**Inhalation**	
Metals						
Aluminum	-	4.E-06	0.0013	0.0001	9.E-07	
Antimony	-	5.E-05	-	-	3.E-05	
Arsenic	-	7.E-05	0.0013	0.0011	6.E-05	
Barium	0.0069	0.0003	0.0018	0.0002	0.0001	
Beryllium	-	7.E-06	-	-	0.0010	
Cadmium	0.0001	2.E-05	0.0007	6.E-06	0.0002	
Chromium	-	-	3.E-06	3.E-07	-	
Chromium (VI)	-	5.E-07	4.E-07	-	0.0005	
Cobalt	-	-	1.E-05	1.E-06	-	
Copper	-	-	0.0003	3.E-05	-	
Manganese	-	2.E-05	-	-	0.0886	
Mercury	-	6.E-05	0.0006	5.E-05	3.E-05	
Molybdenum	0.0001	-	-	-	-	
Nickel	-	6.E-06	0.0002	2.E-05	3.E-06	
Silver	9.E-06	-	-	-	-	
Strontium	0.0002	-	0.0003	3.E-05	-	
Vanadium	-	-	0.0004	3.E-05	-	
Zinc	0.0001	-	0.0003	2.E-05	-	
Lanthanides						
Lanthanides	-	0.0045	0.0134	0.0187	0.8700	
Other Inorganics						
Chlorine	-	-	-	-	0.1600	
Hydrochloric Acid	-	-	-	-	0.0131	
Phosphorus	-	-	-	-	0.0005	
Sodium	-	-	-	-	2.E-05	
Organics						
Acetaldehyde	-	-	-	-	0.0014	
Acrolein	-	-	-	-	0.1760	
Benzene	-	-	-	-	0.0012	
Benzo(a)anthracene	-	-	-	-	4.E-08	
Benzo(a)pyrene	-	-	-	-	3.E-08	
Benzo(b)fluoranthene	-	-	-	-	2.E-08	
Benzo(k)fluoranthene	-	-	-	-	3.E-07	
Chrysene	-	-	-	-	4.E-08	
Crotonaldehyde	-	-	-	-	0.0002	
Dibenz(a,h)anthracene	-	-	-	-	2.E-08	
Ethylbenzene	-	-	-	-	3.E-07	
Formaldehyde[2]	-	-	-	-	0.0134	
Indeno(1,2,3-c,d)pyrene	-	-	-	-	2.E-08	
Naphthalene	-	-	-	-	0.0013	
o-Xylene	-	-	-	-	4.E-07	
PAH (Total)	-	-	-	-	1.E-08	
Proprionaldehyde	-	-	-	-	0.0008	
Toluene[2]	-	-	-	-	2.E-05	
Trimethylbenzene	-	-	-	-	0.0004	
Uranium	-	-	0.0001	1.E-05	-	
Xylenes	-	-	-	-	2.E-07	
Hazard Index (HI) by Health Effect*						**Summation**
Respiratory	-	-	-	-	**1.2**	**1.2**
Other	0.007	0.005	0.021	0.020	0.1	0.2

Key:

1 - Baseline and Incremental Future hazard quotients (HQs) include incidental soil ingestion and dermal contact with soil. hazard indices (HIs) for future soil contact are the sum of baseline and incremental future HQs.

2 - For inhalation pathway, chemical has known respiratory effects as well as other effects (see Table 2-21), and is therefore summed in both health effects categories.

BOLD **Hazard Quotient or Hazard Index > 1**

* HQs are summed by health effect; colors show the potential health effect caused by each COPC.

3.0 ECOLOGICAL RISK ASSESSMENT

The California Environmental Quality Act (CEQA) requires that the environmental impacts of proposed projects be evaluated and that feasible methods to reduce, avoid, or eliminate significant adverse impacts of these projects be considered (ENSR 1996). The ecological risk assessment (ERA) for the Mountain Pass mine and mill site evaluates the likelihood of adverse ecological effects that may occur as a result of activities at the mine and mill facility. The ERA process is used to systematically evaluate and organize data, information, assumptions, and uncertainties to help understand and predict the relationships between chemical stressors and ecological effects in a way that is useful for environmental decision-making (USEPA 1998b). Results of the ERAs for baseline, future expansion, and reference scenarios will be included in the EIR and assist evaluations of the proposed expansion plan.

For the mine and mill site, baseline scenario ERAs evaluate potential risks that may arise as a result of metal, lanthanide series metals (referred to as lanthanide metals), thorium, uranium, and radionuclide releases that occurred during mining and milling operations prior to 01 January 1998. Future expansion scenario ERAs evaluate potential future risks that may arise as a result of possible metal, lanthanide metal, and radionuclide releases occurring during mining and milling operations associated with the proposed mine expansion project. Reference scenario ERAs evaluate potential risks due to exposure to background concentrations of metals, lanthanide metals, and radionuclides, and are intended to provide a point-of-reference for comparisons to baseline and future expansion risk scenarios.

Risks to biota due to the direct or indirect loss of habitat as a result of proposed expansion activities were not addressed by ERAs for the baseline or future expansion scenarios. However, the consequences of potential loss of habitat resulting from proposed expansion alternatives will be addressed in the EIR by ENSR.

The approach for conducting ERAs for baseline, future expansion, and reference scenarios is consistent with California and federal guidance (DTSC 1996; USEPA 1998b), was reviewed and approved by the Technical Work Group (TWG), and is described in detail in the HHERA work plan (see Appendix I). Quantitative analyses conducted and described in this report are sufficient and wholly consistent with a screening-level ERA. Consideration of further site-specific efforts to verify analyses of exposures or effects described in this report may be addressed in the EIR.

In addition to the specific methods, the following products and input values were reviewed and approved by the Technical Work Group prior to evaluations of risk:

- Potentially affected habitats and receptors of concern
- Exposure pathway conceptual site models
- Assessment endpoints and measures of effects
- Indicator species
- Wildlife exposure factors
- Bioaccumulation factors
- Bioaccessibility factors
- Toxicity values
- Uncertainty factors

To facilitate review, Section 3.0 is organized as follows:

- Section 3.1: Problem formulation
- Section 3.2: Analysis
- Section 3.3: Risk characterization
- Section 3.4: Uncertainty analysis
- Section 3.5: Summary

3.1 PROBLEM FORMULATION

Problem formulation establishes the scope of the ecological risk assessment and identifies the major factors to be considered. Major factors identified in this ERA include:

- Potentially affected areas
- Receptors of concern
- Potentially complete exposure pathways
- Constituents of potential concern

Identification of these features of the site ensures that ecological receptors likely to be exposed and exposure scenarios most likely to contribute to ecological risk are evaluated.

3.1.1 Areas of Concern and Reference Background Locations

To focus the ERAs, areas of concern (AOCs) and reference background locations were identified at the mine and mill site.

Areas of Concern. AOCs are defined as areas potentially affected by mine and mill site activities (1) that support (or, are suitable to support) plants, invertebrates, or wildlife receptors, or (2) where the lack of plants, invertebrates, or wildlife is due to the presence of released constituents. Ecological risks were evaluated for twelve onsite AOCs and one potentially affected offsite area (*i.e.*, Wheaton Wash/Roseberry Spring). AOCs identified for the mine and mill site are shown in Figure 3-1.

Although drainages, developed water impoundments, and intermittent onsite springs are unlikely to be considered jurisdictional waters or wetlands under Section 404 of the Federal Clean Water Act (Dames & Moore 2000a), some of these areas at the mine and mill site were considered to offer intermittent aquatic habitat that may support aquatic invertebrates or attract wildlife receptors. To provide a protective ERA, several of these areas were identified as AOCs.

ERAs for the baseline and future scenarios were conducted for the Seepage Collection Ponds (P23ab), Lanthanide Storage Ponds (P25ab, P28), and Sewage Treatment Pond (P19) at the mine and mill site because these ponds are potential sources of chemical exposure and may be attractive to wildlife seeking a source of drinking water (Table 3-1). As agreed to by the Technical Work Group, risks to aquatic or sediment-associated biota were not evaluated at these developed water impoundments. Baseline risks were used to represent risks under the future expansion scenario since no future change is anticipated under the proposed project.

ERAs for the baseline scenario were also conducted for onsite and offsite intermittent springs that are downgradient from developed water impoundments:

- 17 Spring (representative of springs in Farmer's Wash, downgradient from P-16)
- Jack Meyer's Pond Spring (representative of springs between P-16 and Mexican Well)
- Wheaton Wash/Roseberry Spring

These intermittent springs are potential sources of chemical exposure and may be attractive to wildlife seeking a source of drinking water. Risk analyses for the future expansion scenario were not conducted for these intermittent springs because future developed water impoundments anticipated under the proposed project plan will be lined (*e.g.*, East Tailings Pond), effectively eliminating their contribution to downgradient springs.

An ERA for the baseline scenario was conducted for the Overburden Stockpile due to the concern that subsurface soils/rock brought to the surface may result in elevated exposures of constituents to plant, invertebrate, and wildlife resources. It should be noted that the Overburden Stockpile provides little attractive habitat to wildlife—this AOC is characterized by extremely hard-packed surface soils in flat areas and boulders on its slope that support little or no vegetation. Under the future expansion scenario, the Overburden Stockpile (west and north areas) will increase substantially in size (from the existing 88 acres to a proposed 305 acres). However, for the future expansion scenario, constituent concentrations in Overburden Stockpile soils were assumed not to change from current conditions; only a larger contaminated area would be exposed.

For the open pit mine, an ERA was only conducted for the future expansion scenario. In the future, the open pit mine may support a groundwater-fed Pit Lake. The Pit Lake was evaluated for potential future risks to ecological receptors. Data for haul road soils and nearby, upgradient groundwater monitoring wells (*i.e.*, Pit Well) were used to represent future conditions at this AOC.

Similarly, an ERA for the future onsite evaporation ponds was only conducted for the future expansion scenario. In the future, onsite evaporation ponds will cover approximately 130 acres in the northwest area of the facility. These onsite evaporation ponds will be surrounded by a fence that will prevent access by the desert tortoise and large mammals. Because these ponds may provide a source of drinking water for birds and small mammals, future onsite evaporation ponds were evaluated for potential future risks to these receptors using modeled concentrations (see *Exposure Point Concentrations* of Section 3.2.1). As agreed to by the Technical Work Group, risks to aquatic or sediment-associated biota were not evaluated at the developed water impoundment—this approach is consistent with ecological risk assessments for surface impoundments across the United States (USEPA 1999c).

ERAs for baseline and future expansion scenarios were not conducted for haul roads and warehouse AOCs (Table 3-1). These areas have been developed for industrial use, are planned for continued industrial use, and are characterized by barren, extremely hard-packed soils due to heavy vehicle and/or human traffic. Due to these physical features, these areas are characterized by either the lack of vegetation or the presence of sparse patches of highly disturbed, ruderal vegetation. This land use (industrial land use) is not intended to and does not support habitat attractive to support native plant and wildlife populations (see Appendix D.1 of Appendix I).

In addition, ERAs for the baseline and future expansion scenarios were not conducted for the Caltrans/CHP residences and Mountain Pass Elementary School. These areas are developed for human use, are highly disturbed, and are characterized by frequent human activity. Wildlife that may be observed in these areas are likely to be transient, introduced species that are tolerant of human activity and typical of highly disturbed areas. Moreover, as directed by the Technical Work Group, samples at these AOCs were specifically collected in locations to assess human exposures (*e.g.*, under swings, in lawns).

Reference Background Locations. Reference background locations were selected to identify metals, lanthanide metals, thorium, uranium, and radionuclides concentrations that are elevated compared to natural background levels (see Section 3.1.3). Risks at reference background locations were also used to provide a point-of-reference for risks predicted under baseline and future expansion scenarios (see Section 3.3).

Reference background locations at the mine and mill site were identified using Gsi/Water's (1998) geology map of the site and subsequent site visits by Tetra Tech geologists and members of the Technical Work Group. Reference background locations for each AOC at the mine and mill site are listed in Table 3-2.

3.1.2 Potentially Exposed Ecological Receptors of Concern

Given current AOC features and habitats as well as surrounding habitat types, mine and mill site AOCs support (or are expected to support) one or more desert habitat types listed in Table 3-3. These desert habitats support a number of plants, invertebrates, and wildlife species (Mayer and Laudenslayer 1998). Given the number of species and the complexity of biological communities, all species present at each AOC cannot be individually assessed. Receptors of concern were identified to (a) focus the ERA on receptors of ecological and resource management concern and (b) develop site-specific assessment endpoint statements (see Section 3.1.5). Methods for identifying and selecting receptors of concern are consistent with state and federal guidance (DTSC 1996; USEPA 1998b) and are provided in Appendix I.

Receptors of concern were identified in each major taxonomic group likely to be found at mine and mill site AOCs:

- Plants
- Aquatic invertebrates
- Soil invertebrates
- Reptiles
- Birds
- Mammals

Fish were not identified as receptors of concern because (a) no fish have been observed in intermittent ponds and springs found at or near the mine and mill site, (b) intermittent ponds and springs are not connected to freshwater systems that support fish populations and (c) intermittent water bodies are not present long enough to sustain fish populations. Likewise, amphibians were not identified as receptors of concern because few amphibians have been observed at the mine and mill site and existing information suggests that amphibians play a relatively minor ecological role in desert habitats (Heatwole 1982).

Receptors of concern were grouped by major feeding types:

- Autotrophs (plants)
- Filter feeders
- Deposit feeders
- Herbivores
- Insectivores
- Carnivores

3.1.3 Potentially Complete Exposure Pathways

Identification of complete exposure pathways focuses the ecological risk assessment on those exposure scenarios that are most likely to put ERA receptors of concern at risk. Potentially complete exposure pathways were defined as pathways having all the following attributes:

- A source and mechanism of constituent release

- A transport medium (*e.g.*, soil, water, tissue)
- A point or area where receptors of concern may contact constituents
- An exposure route through which constituent uptake occurs (*e.g.*, ingestion)

An exposure pathway conceptual site model (CSM) for the mine and mill site is shown in Figure 3-2 and is intended to identify, to the best of our current knowledge, sources, mechanisms of transport, media of concern, exposure routes, and receptor groups.

The following exposure pathways were evaluated in the ERA:

Aquatic Receptors

- Bioaccumulation[1] of constituents in surface water by aquatic invertebrates;
- Bioaccumulation of constituents from sediment by sediment-associated invertebrates;
- Internal and external irradiation by radioactive constituents in surface water.

Terrestrial Receptors

- Bioaccumulation of constituents from soil by ground cover plants, shrubs, and trees
- Bioaccumulation of constituents from soil by soil invertebrates
- Incidental ingestion of constituents in soil by wildlife
- Ingestion of constituents in surface water by wildlife
- Inhalation and subsequent ingestion[2] of non-radioactive constituents in fugitive dust by wildlife
- Ingestion of constituents in food items (*i.e.*, plant, invertebrate, or wildlife tissues) by wildlife
- External irradiation by radioactive constituents in soils
- Internal irradiation from inhalation of radioactive constituents in fugitive dust
- Internal irradiation by radioactive constituents in ingested soils, foods, and fugitive dusts

Shallow groundwater (less than 20 ft bgs[3]) was considered accessible to deep-rooted plants and was evaluated. However, groundwater located at depths greater than 20 feet bgs is considered to be inaccessible to plants and wildlife, and was not evaluated.

As directed by the Technical Work Group, bioaccumulation by aquatic and sediment-associated invertebrates was not evaluated for developed water impoundments—but was evaluated at the Administration Pond, 17 Spring, Jack Meyer's Pond Spring, and Roseberry Spring in Wheaton Wash (see Section 3.1.1; Figure 3-1).

Dermal absorption of metals is considered to be an insignificant exposure pathway for identified wildlife receptors of concern because:

- Dense undercoats or down effectively prevent the metals from reaching the skin of wildlife and significantly reduce the total surface area of exposed skin (Peterle 1991; USACE 1996)
- Results of exposure studies indicate that exposures due to dermal absorption are insignificant compared to ingestion for terrestrial receptors (Peterle 1991)

Consequences of omitting the dermal pathway are discussed in Section 3.4.1.

Internal irradiation (via inhalation of fugitive dust and ingestion of metals) was evaluated for wildlife. However, carnivorous birds (*e.g.*, raptors) typically do not spend enough time on or near the ground for inhalation of

[1] Bioaccumulation is defined as the uptake and retention of substances by an organism (via any combination of exposure routes) from its surrounding medium.

[2] The approach for addressing the inhalation of fugitive dust for non-radioactive constituents assumes that (1) fugitive dust is inhaled, (2) the majority of inhaled fugitive dust adheres to mucous, and (3) the mucous is subsequently swallowed.

[3] bgs = below ground surface

fugitive dusts to be a significant pathway. Likewise, far-ranging wildlife (*e.g.*, coyote, burros) are unlikely to spend enough time in a potentially affected area for inhalation of fugitive dusts to be a significant exposure pathway. Inhalation of fugitive dusts was evaluated only for wildlife with small home ranges. Wildlife with relatively small home ranges (*i.e.*, home ranges comparable to AOC areas) are likely to have higher exposures to fugitive dust at AOCs than far-ranging wildlife because they spend more of their time at the AOC.

Similarly, external irradiation was evaluated for small herbivorous and insectivorous birds—external irradiation was not evaluated for carnivorous birds (*e.g.*, raptors) because these birds typically do not spend enough time on or near the ground for external irradiation to be a significant exposure pathway. Herbivorous and insectivorous birds are likely to have higher external irradiation exposures than carnivorous birds because they spend more of their time near the ground foraging for food.

3.1.4 Constituents of Potential Concern

Constituents of potential concern (COPCs) are detected metals, lanthanide metals, thorium, uranium, and/or radionuclides that may adversely affect receptors of concern.

Metals and radionuclides occur naturally in soils, surface water, and groundwater at the mine and mill site. One method for focusing the ERA is to screen for those constituents with concentrations that are elevated compared to natural background levels (see *Reference Background Locations*). In accordance with Cal/EPA (1997) guidance, the Wilcoxon Rank Sum (WRS) test was used to identify elevated metals, lanthanide metals, thorium, uranium, and/or radionuclides at each AOC. The radionuclides were assumed to be in secular equilibrium, so if the parent or one daughter product was found to be elevated, the entire decay chain was also assumed to be COPCs.

In order to provide a valid comparison to background risk estimates, constituents identified as COPCs in one medium at a given AOC were considered to be COPCs in all AOC media contacted by a particular receptor. Since different receptors are exposed to different media, COPCs will vary by receptor:

- Soil COPCs—Plants/Soil invertebrates[4] (Table 3-4a)
- Surface water COPCs—Aquatic invertebrates[4] (Table 3-4b)
- Sediment COPCs—Sediment-associated invertebrates[4] (Table 3-4c)
- Soil and surface water COPCs—Terrestrial wildlife (Table 3-4d)
- Sediment and surface water COPCs—Waterfowl (Table 3-4e)

A more detailed description of the methods used to identify COPCs is provided in Appendix I.

3.1.5 Assessment Endpoints, Measures of Exposure, and Measures of Effect

A key goal of the EIR is to identify and characterize "significant adverse impacts" of the proposed expansion plan, so that feasible methods to reduce, avoid, or eliminate these impacts may be considered (ENSR 1996). Assessment endpoints are "explicit expressions of the actual environmental value that is to be protected" (USEPA 1992c, 1998b). An assessment endpoint consists of:

- A specific ecological entity (*e.g.*, species, functional group [herbivores], ecosystem [desert scrub])
- A specific characteristic of the entity that is important to protect and that is potentially at risk (*e.g.*, plant productivity, persistence of the population)

Assessment endpoints link the risk assessment to management concerns to ensure that the ERA provides information to assist in decision-making. To support the EIR, assessment endpoints for this ERA help define "significant adverse impacts" and focus ERA analyses.

[4] Considered to be intimately associated with media.

Measures of exposure are measures of stressor existence and movement in the environment and their contact or co-occurrences with receptors of concern (USEPA 1998b). The measures of exposure include COPC concentrations in soils, sediments, surface water, and groundwater at mine and mill site AOCs. Exposures to receptors were estimated using exposure models consistent with U.S. EPA's Wildlife Exposure Factors Handbook (1993) (see Section 3.2.1).

Measures of effect are measurable responses to a stress that are related to and are used to evaluate the assessment endpoint (USEPA 1998b). The primary measures of effect used in the ERAs are water quality criteria, sediment quality guidelines, soil qualify guidelines, and chronic reproductive or developmental impairment toxicity data for birds and mammals (see Section 3.2.2).

Assessment endpoints and measures of effect for the mine and mill site are listed in Table 3-5.

3.2 ANALYSIS

Analysis is a process that examines the two primary components of risk: exposure and effects (USEPA 1998b). The analysis phase provides the information necessary to determine or predict ecological responses to COPCs under exposure conditions of interest.

3.2.1 Exposure Assessment

Data used to estimate exposures are discussed in Section 1.6, are summarized in Table 1-3, and are presented in Appendix II. To estimate exposures of COPCs to selected plant, invertebrate, and wildlife species at the mine and mill site, six essential inputs were needed:

- Indicator species
- Exposure equations
- Exposure point concentrations
- Wildlife exposure factors
- Site presence
- Bioaccumulation factors
- Bioaccessibility factors

Further explanation of exposure assessments is provided in Appendix I. To facilitate review, all input values used to estimate exposures and risk estimates are provided in Appendix VI.

Indicator Species. Because it is impractical to evaluate all receptors of concern at an AOC, the ERAs evaluate risks for a representative set of indicator species that are selected for each AOC. Risks to indicator species are subsequently used to infer the potential for adverse impacts to taxonomically and functionally related receptors of concern. Indicator species were selected to minimize underestimates of exposure and are listed in Table 3-6.

It should be noted that risks to plants and invertebrates were not inferred based on risks to indicator species—risks were evaluated using community-level toxicity values (Section 3.2.2). Fairy shrimp, amphipod, big galleta grass, juniper, and earthworm were selected as indicator species primarily to obtain body dimensions should radiation exposures be required. In addition, the earthworm was used to estimate exposures to insectivorous wildlife because more soil-to-soil invertebrate bioaccumulation factors exist for the earthworm than other soil invertebrates.

Exposure Equations. Exposure equations are used to calculate exposures to indicator species. To facilitate comparisons with available toxicity data, estimates of exposure for metals and lanthanide metals were reported in the following units:

Aquatic Receptors

- Exposure to aquatic invertebrates ($\mu g_{COPC}/L$)
- Exposure to sediment-associated invertebrates ($mg_{COPC}/kg_{sediment}$)

Terrestrial Receptors

- Exposure to plants and soil invertebrates (mg_{COPC}/kg_{soil})
- Exposure to trees from shallow (< 20 ft bgs) groundwater ($\mu g_{COPC}/L$)

- Exposure to terrestrial wildlife ($mg_{COPC}/kg_{body\ wt}$-day)

Estimates of exposure for aquatic invertebrates, sediment-associated invertebrates, plants, and soil invertebrates are in units of media concentration and, therefore, did not require exposure equations—exposure equations were only needed for wildlife species.

COPC exposures to wildlife indicator species were calculated using pathway-specific *exposure equations* of the form (DTSC 1996; USEPA 1993):

$$\text{Dose} = C \cdot CR \cdot FC \cdot AF \cdot BW^{-1}$$

where *C* is the COPC concentration in the medium, *CR* is contact (or intake) rate, *FC* is the fraction of media contacted (*e.g.*, diet proportions), *AF* is the assimilation (or bioaccessibility) factor, and *BW* is body weight. Exposure equations that were used to estimate ingested metal exposures to wildlife receptors are provided in Section 5 of Appendix I.

Radiation exposures to indicator species were evaluated using the Department of Energy Standard (USDOE 2000) (see Table 5-4 of Section T5.5 of Appendix I). The graded approach described in the DOE Standard (2000) instructs that organisms or areas that have a sum of fractions (calculated radiation dose *vs*. the reference radiation dose) value less than one do not have any measurable adverse effect due to radiological exposure. For areas and organisms that exceed a sum of fractions value of one, the DOE Standard recommends that an ecological risk assessment be performed.

Exposure Point Concentrations. An exposure point concentration (EPC) is an estimate of the concentration of a COPC in a particular environmental medium (*e.g.*, surface soil) at a particular AOC. In accordance with regulatory guidance, the lesser value of (1) the upper 95th percent confidence limit on the mean[5] (UCL95) or (2) the maximum detected concentration in the accessible media was used to estimate exposure (USEPA 1989a). Since sampling at Mountain Pass Mine has focused on characterizing areas known or suspected to have received released constituents, the protocol for calculating EPCs is likely to result in conservative estimates of EPCs. EPCs for each AOC are listed in tables of Appendix VI.1.

Future EPCs for the proposed onsite evaporation ponds were predicted using models described in Appendix D.6 of Appendix I. The future wastestream feed will undergo treatment and filtering prior to being discharged to onsite evaporation ponds. To ensure a conservative assessment, the modeled concentrations assume failure of these reduction measures. Predicted concentrations for surface water and solids at the proposed future onsite evaporation ponds were based on (1) four years of data on the wastestream feed to New Ivanpah Evaporation Pond, (2) increased concentration of constituents in the future wastestream feed due to decreased flow, (3) increased concentration of constituents due to evaporation at the future ponds, and (4) steady-state equilibrium conditions in future onsite evaporation ponds where total dissolved solids (TDS) will be maintained at a concentration of 250,000 mg/L. An example calculation is provided in Table 3-7.

Wildlife Exposure Factors. To estimate exposures, the following wildlife exposure factors were required:

- Water (drinking) and food ingestion rates
- Inhalation rates
- Soil and food diet proportions
- Foraging area or home range
- Body dimensions (*i.e.*, weight, length, width, height)

Wildlife exposure factors used to estimate exposures to indicator species were obtained from the peer-reviewed literature and are provided in Table 3-8. These wildlife exposure factors were reviewed and approved by the Technical Work Group and by Mr. Peter Woodman, a recognized desert wildlife biologist and desert tortoise expert.

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[5] Details of the statistical analyses required to calculate the UCL95 are provided in Appendix I.

Site Presence Index. The site presence index is used to estimate the fraction of time that a receptor is likely to spend at a particular AOC and is defined as the ratio of the AOC area to the foraging area of a given receptor. AOC areas are provided in Table 3-1 and foraging areas for wildlife indicator species are provided in Table 3-8.

Because the boundaries of mine and mill site AOCs were difficult to accurately determine, all mine and mill site AOCs are assumed to have an area of 13 hectares (except for the Overburden Stockpile). An AOC area of 13 hectares conservatively encompasses identified AOCs (see Figure 3-1) and ensures that all HHERA-related samples and relevant CAO-related samples are used to characterize conditions at the AOC.

The Overburden Stockpile has a reported area of approximately 88 acres (36 ha) (west and north areas), almost three times the area of other AOCs (Molycorp 1999). Under the future expansion scenario, it will increase substantially in size, to a proposed 305 acres (123 ha).

As indicated in Table 3-9, use of these AOC areas results in site presence indices wherein all but the far-ranging wildlife indicator species spend a majority of their time at mine and mill site AOCs.

Bioaccumulation Factors. COPC concentrations transferred up the food chain were calculated using chemical-specific soil-to-plant, soil-to-soil invertebrate, soil-to-small mammal, and sediment-to-sediment associated biota bioaccumulation factors. Most of these bioaccumulation factors were derived from log-linear regression models provided in Sample *et al.* (1998ab, 1999) and Bechtel Jacobs Company LLC (1998ab). Log-linear regression models are recommended for use in ecological risk assessments because the available data indicate that bioaccumulation by plants, soil invertebrates, sediment invertebrates, and small mammals is non-linear, decreasing with increasing soil concentrations (Sample et al. 1998ab; Bechtel Jacobs Company LLC 1998ab). Log-linear regression models, however, were not available for several constituents, most notably lanthanide series metals. For these constituents, point estimate bioaccumulation factors (which assume that accumulation is linear across all soil concentrations) were obtained from Baes *et al.* (1984). Bioaccumulation factors and food tissue burdens used in the ERAs are provided in tables of Appendix VI.2 and Appendix VI.3.

Bioaccessibility Factors. Bioaccessibility[6] factors were derived from the results of *in vitro* bioaccessibility studies that measured the proportion of the total concentration that is soluble in a solution that mimics conditions in the mammalian gastrointestinal tract (Drexler 1999; see also Appendix I.C.3). Bioaccessibility factors were only developed for mammals and are available specifically for soils at the mine and mill site and for solids associated with the wastestream to evaporation ponds:

	Bioaccessibility Factor	
Constituent	AOCs	Onsite Evap Pond
Lanthanides	6%	68%
As	28%	57%
Pb	56%	48%

Where bioaccessibility factors were not available, ingested exposures were calculated using a default bioaccessibility factor of one (*i.e.*, all ingested constituents are assimilated across the gut wall and into the body).

Example Exposure Calculations. To ensure that calculations of exposure are clear, example exposure calculations are provided in Table 3-10 and Table 3-11. Table 3-10 provides example calculations for exposures to lead and lanthanum by a coyote that ingests herbivorous prey, soils (incidentally), and surface water. The lead example shows how regression models are used to estimate tissue concentrations in prey, while the lanthanum example shows how biotransfer factors are used to estimate concentrations in prey.

[6] Bioaccessibility is defined as the amount of an administered substance that crosses the gastrointestinal wall.

An example calculation for the absorbed radiation dose is provided in Table 3-11.

3.2.2 Effects Assessment

The effects assessment establishes concentrations in media or doses of COPCs that pose a potential for adverse ecological effects to receptors of concern at the mine and mill site.

To calculate hazard quotients, reference toxicity values (RTVs) are needed. The RTV is defined as the dose or the media concentration (*e.g.*, concentration in soil) of a particular COPC that is protective of a particular plant, invertebrate, or wildlife receptor. Ideally, the RTV is the highest dose or media concentration at which no chronic effects occur, and above which chronic adverse effects begin to occur.

RTVs used in ERAs for AOCs at the mine and mill site were derived from both primary and secondary sources in the toxicology literature:

- *Plant Communities*—reference phytotoxicity values (Efroymson *et al*. 1997).
- *Aquatic Invertebrate Communities*—National Ambient Water Quality Criteria for the Protection of Freshwater Biota (US EPA 1999d).
- *Sediment-Associated Invertebrate Communities*—Effects Range-low (ER-L) values (Long *et al*. 1995).
- *Soil Invertebrate Communities*—Ecotoxicological Intervention Values (van den Berg *et al*. 1993)
- *Bird and Mammal Populations*—chronic NOAELs derived from specific studies in the primary literature.

The RTV for radionuclides was obtain directly from data presented in IAEA (1992).

Studies examining reproductive impairment or developmental abnormalities were preferred for avian and mammalian wildlife because these responses can be directly related to assessment endpoints of individual fitness (*i.e.*, the ability of individuals to leave viable offspring to the next generation) and the persistence of populations. Ecologically relevant study features that were used to select among several relevant reproductive or developmental studies include those in which:

- Doses were administered during critical and sensitive periods (*e.g.*, during gestation) and/or effects on sensitive life stage (*e.g.*, effects on fetuses, embryos)
- Chronic exposures (> 50% of the life span) or doses were administered-through most of the reproductive period
- Use of a serial dosing regime, especially a serial dosing regime in which both a NOAEL and LOAEL were reported
- Large "per treatment" sample sizes were examined
- Methods and results of statistical analyses were described
- Wildlife species were examined in the study

Toxicity profiles for ecological receptors are consistent with federal and California guidance (USEPA 1992c; DTSC 1996) and are provided in Appendix D.5 of Appendix I.

Uncertainty Factors. As agreed by the TWG, the following uncertainty factors were applied to convert toxicity data to chronic NOAEL-equivalent RTVs:

Extrapolation	UF
Acute LD_{50} to chronic NOAEL	100
LOAEL to NOAEL	10
Subchronic to chronic	10

These uncertainty factors are consistent with uncertainty factors used in human health risk assessments (Dourson and Stara 1983; Calabrese and Baldwin 1993). All chronic NOAEL-equivalent RTVs used in the ERAs are provided in Table 3-12. Further detailed information (*e.g.*, references) on each RTV is provided in Appendix D.5 of Appendix I (see Tables D5.2-2 through D5.2-7).

Toxicity Data Gaps. The lack of toxicity data for the desert tortoise was identified as a data gap. Evaluations of risk to the desert tortoise based on relative exposures alone are unsatisfactory because there is no link from exposures to effects. Risks to the desert tortoise were evaluated using available avian toxicity reference values as surrogate reptilian toxicity reference values[7]. Avian RTVs were adjusted by dividing by a factor of 20 to (1) account for the extrapolation of RTVs from birds to reptiles (*i.e.*, between classes of vertebrates) and (2) ensure protective risk estimates for the desert tortoise, a federally listed threatened species (see Section T5.8.2 of Appendix I). Uncertainties related to the use of these surrogate toxicity reference values are discussed in the Uncertainty Analyses (Section 3.4.2).

Relevant lanthanide toxicity data for mammals was limited, but sufficient to develop a chronic NOAEL RTV. Insufficient lanthanide metal toxicity data were available to derive RTVs for aquatic invertebrates, sediment-associated invertebrates, plants, reptiles, and birds.

The lack of reptilian and lanthanide toxicity data is discussed in Section 3.4.2.

3.3 RISK CHARACTERIZATION

Risk characterization integrates the results of the analysis phase (*i.e.*, exposure and effects assessments) to evaluate the likelihood of adverse ecological impacts associated with exposure to COPCs (USEPA 1992c, 1998b).

The hazard quotient (HQ) was used to estimate the potential for adverse ecological impacts when sufficient exposure and toxicity data exist. Other factors were considered when interpreting the ecological significance of potential risks.

The risk characterization is organized by receptor group (see Sections 3.3.1 through 3.3.5)

Hazard Quotients. For each COPC, an HQ is simply the ratio of the estimated exposure to the chronic no observable adverse effect level (NOAEL)-equivalent reference toxicity value (RTV):

$$HQ = \frac{\text{Estimated Exposure}}{\text{Chronic NOAEL-equivalent RTV}}$$

Thus, HQs are one or greater when estimated exposures are equal to or exceed the highest dose at which no adverse effects were observed.

HQs were calculated for exposures at AOCs (HQ_{AOC}) and for exposures at the reference background locations ($HQ_{Bckgrnd}$). Values used to calculate HQs for each receptor are provided in Appendix VI.2 and Appendix VI.3.

Comparisons to Background. For several AOCs, more than one reference background soil type was found in adjacent/nearby areas (Table 3-2). However, to ensure that all potential constituents were included in the ERA, the TWG decided to use the most conservative background soil type[8] to identify COPCs at each AOC. Since nearby background soil types frequently contain higher concentrations of constituents, exposures to COPCs at the AOC may be comparable to other nearby background soils. Given the approach taken to scope the ERA, comparisons to background risk estimates provide a relevant point-of-reference for AOC risk estimates.

As agreed by the TWG, a negligible potential for adverse ecological impacts exists when:

1. Estimated exposures at the AOC are less than the highest dose at which no adverse effects were observed (*i.e.*, $HQ_{AOC} < 1$)

OR

[7] Most paleontologists agree that birds were derived from a group of reptiles called thecodonts (Hickman *et al.* 1974). This phylogenetic relationship between reptiles and birds suggests that comparisons of reptile exposure to avian toxicity data may provide a reasonable, relevant point-of-reference for assessing potential effects to reptiles.

[8] Soil type with the lowest naturally occurring metal concentrations.

2. There is no greater potential for adverse impacts at the AOC compared to relevant reference background locations (*i.e.*, $HQ_{AOC} \leq HQ_{Bckgrnd}$).

Relevant reference (*i.e.*, naturally occurring background soil) locations for each AOC are presented in Table 3-2.

Two methods may be used to compare AOC risk estimates to background risk estimates: absolute differences (*i.e.*, HQ_{AOC} - $HQ_{Bckgrnd}$) and relative differences (*i.e.*, $HQ_{AOC}/HQ_{Bckgrnd}$) in risk estimates. Relative differences (hereafter referred to as relative risks) were the preferred comparison because these comparisons put absolute differences into perspective. For example, an absolute difference of 2 would suggest a potential for adverse impacts and would indicate a substantial increase in the risk estimate if the background risk estimate were 1; whereas, an absolute difference of 2 would indicate a marginal increase in the risk estimate if the background risk estimate were 200. Thus, for the purposes of this risk assessment, relative risks were considered to provide the most relevant and useful information to support planning at the mine and mill site.

To support this decision tree, relative risks were evaluated according to:

1. *IF* HQ_{AOC} is less than one *or* less than or equal to $HQ_{Bckgrnd}$,
   THEN, the relative risk estimate is HQ_{AOC}.
2. *IF* HQ_{AOC} is greater than or equal to 1 *and* $HQ_{Bckgrnd}$ is less than one,
   THEN, the relative risk estimate is HQ_{AOC}
3. *IF* HQ_{AOC} is greater than or equal to 1 *and* $HQ_{Bckgrnd}$ is greater than or equal to one,
   THEN, the relative risk estimate is $HQ_{AOC}/HQ_{Bckgrnd}$.

To promote the readability of this report, risk estimate summary tables (Tables 3-13 to 3-26) in the body of the report show HQs that are color-coded according to relative risks (see also Appendix VI.4).

Risk Interpretation. As identified in current ERA guidance (USEPA 1998b), professional judgment plays a significant role in the interpretation of risk. In support of the EIR, other factors that were considered when interpreting the ecological significance of the risks include:

- Presence of threatened or endangered species
- Quality of potentially affected habitats
- Potential for recovery

Consideration of these other factors is intended to increase confidence in risk management decisions by using several different types of information in the decision-making process. To support the EIR and to assist decision-makers, the potential for and the ecological significance of adverse impacts resulting from activities at mine and mill site AOCs are provided in this screening-level ERA.

Presence of Threatened or Endangered Species—Areas that support federal- or state-listed threatened or endangered species were considered to be of greater ecological significance compared to sites where these species have not been observed or are not expected.

Quality of Potentially Affected Habitats—Qualitative assessments of habitat quality were based on visual observations performed during the June 1999 sampling effort. Photographs of nine AOCs and one reference background location (*i.e.*, older alluvium) are provided to support qualitative characterizations of habitat quality (Figures 3-3 to 3-12).

Habitats that were considered of greater ecological significance include:

- Limited or rare habitat that provides critical breeding, stopping over, or refuge for identified receptors of concern;
- Potentially affected habitat that is a significant portion of the entire habitat in the vicinity of the mine and mill site;

- Habitat that is preferred by threatened or endangered species; and
- Habitat that is located in areas designated as critical wildlife management areas (*e.g.*, BLM has designated critical desert tortoise habitat) or wildlife refuges.

Habitats of lesser ecological significance include (1) highly disturbed, non-native habitats in areas designated as industrial or commercial use and (2) potentially affected habitats that represent only a small portion of much larger, abundant habitats.

Potential for Recovery—Populations or communities that are unlikely to or are slow to recover from disturbance were considered to be of greater ecological significance compared to populations or communities that recover rapidly. In general, populations or communities that are comprised of organisms that (a) are vagile, (b) have short generation times, and (c) produce many offspring have a greater potential to recover more quickly than populations comprised of organisms that (a) have limited movement, (b) possess long generation times, and (c) produce few offspring (Ricklefs 1990).

3.3.1 Potential Risks to Aquatic and Sediment-Associated Invertebrates

Ephemeral waters in the desert can be viewed as "small aquatic islands in a vast sea of aridity" (Crawford 1981). These "islands" are populated by small, endemic aquatic and sediment-associated invertebrates (*e.g.*, fairy shrimp) that can endure long periods of drought. When water becomes available, these organisms switch from dormant stages to stages that rapidly develop and reproduce. Before the water disappears, aquatic and sediment-associated invertebrates reproduce, leaving a great number of dormant eggs to begin the cycle anew.

Aquatic and sediment-associated invertebrates filter food from the water column or feed on food adsorbed on sediments. Members of aquatic and sediment-associated communities are a food source for waterfowl and wading birds that may forage at aquatic habitats. Risks to aquatic and sediment-associated invertebrates were assessed at the community-level.

Hazard Quotients. HQs calculated for aquatic and sediment-associated invertebrates are provided in Tables 3-13 to 3-14. The HQs (color-coded according to relative risks) suggest that:

Aquatic Invertebrate Communities

1. Barium, lead, strontium, and uranium (and, to lesser degree, beryllium, manganese, nickel, selenium, silver, and vanadium) in surface water at onsite springs pose a potential risk to aquatic invertebrates.
2. Strontium, silver, and uranium (and, to a lesser degree barium, beryllium, cadmium and lead) in surface water at Roseberry Spring (offsite spring) pose a potential risk to aquatic invertebrates.
3. Strontium and uranium (and, to a lesser degree boron, lead, manganese, and selenium) in surface water at the future Pit Lake pose a potential risk to aquatic invertebrates.
4. Conversely, radionuclides in surface water at onsite and offsite springs and at the future Pit Lake pose a negligible risk to aquatic invertebrates.

Sediment-Associated Invertebrate Communities

5. Lead and mercury in sediments at onsite springs (and, to a lesser degree, antimony, arsenic, copper, nickel, zinc) pose a potential risk to sediment-associated invertebrates.
6. To a lesser degree than onsite springs, lead, mercury, and nickel in sediments at Roseberry Spring (offsite spring) pose a potential risk to sediment-associated invertebrates.
7. Conversely, radionuclides in sediments pose a negligible risk to sediment-associated invertebrates.

Presence of Threatened or Endangered Species. No threatened or endangered aquatic invertebrates or sediment-associated invertebrates have been reported at aquatic habitats at the mine and mill site (Lilburn 1990-1996; Dames & Moore 2000b).

Quality of Potentially Affected Habitats. Based on visual observations, surface water at the Administration Pond is considered to offer attractive aquatic habitat. Emergent vegetation and aquatic insects were observed during the June 1999 field sampling effort (Tetra Tech 2000a). The source of surface water at this pond is groundwater that is pumped and transported from Shadow Valley.

Intermittent surface water at Jack Meyer's Pond Spring is considered to offer marginal to adequate aquatic habitat. Emergent vegetation and aquatic insects were observed during a recent field sampling effort (Tetra Tech 2000a) (Figure 3-3). Surface water at the North Tailings Pond is the likely source of this shallow groundwater-fed pond (pers. comm., G.Nason 1999). Following the closure of the North Tailings Pond and the establishment of the lined East Tailings Pond (see Section 1.3), little surface water may be available at Jack Meyer's Pond Spring.

At 17 Spring, intermittent surface water was sampled from a series of small, shallow groundwater-fed puddles created by feral burros (Figure 3-4). Although salt cedar trees provided ample shade in this area, no emergent vegetation or aquatic invertebrates were observed in these puddles during the June 1999 field sampling effort (Tetra Tech 2000a). Surface water at the North Tailings Pond is the likely source of these shallow groundwater-fed puddles (pers. comm., G.Nason 1999). The quality of aquatic habitat at 17 Spring is poor. However, evidence of burro tracks and scat suggest 17 Spring may be an attractive drinking water source.

Roseberry Spring is considered to offer attractive intermittent aquatic habitat—abundant riparian vegetation is observed at and around Roseberry Spring. Due to the lack of surface water during the field sampling effort, aquatic exposures at Wheaton Wash/Roseberry Spring are based on data from shallow groundwater monitoring wells. The rationale is that shallow groundwater discharges to the surface at Roseberry Spring during and immediately following the wet season. However, whether shallow groundwater provides an accurate estimate of surface water concentrations at this intermittent spring remains unverified.

Following closure of the mine and mill site, it is predicted that groundwater upgradient from the open pit mine will discharge into the open pit mine, forming a pit lake. It is assumed that this Pit Lake will offer attractive aquatic habitat. Data from nearby, upgradient groundwater monitoring wells (*i.e.*, Pit Well) were used to predict aquatic exposures at the future Pit Lake. The rationale is that nearby, upgradient groundwater will be the source of the Pit Lake water and provide a reasonable (though unverified) estimate of future surface water exposures.

Potential for Recovery. Aquatic invertebrates associated with intermittent surface waters in arid environments have evolved to quickly hatch from resistant dormant stages, develop, and reproduce in relatively large numbers. These traits would suggest that aquatic invertebrates might recover relatively rapidly given a source of water.

Colonization of new aquatic habitats may take some time because aquatic invertebrates require a vector to move from one isolated ephemeral waterbody to another. Wading birds are one vector for transporting dormant eggs to new waterbodies (Crawford 1981).

Potential for and Ecological Significance of Adverse Impacts. HQs suggest that elevated metal concentrations in water and sediments at springs located in the main drainages downgradient from the North Tailings Pond (*i.e.*, 17 Spring, Jack Meyer's Pond Spring) pose a potential risk to aquatic and sediment-associated invertebrate communities. Analyses of relative risks suggest that (a) exposures to barium, lead, strontium, and uranium pose the greatest risk at 17 Spring and Jack Meyer's Pond Spring (onsite springs); (b) exposures to silver and strontium pose the greatest risk at Roseberry

Spring (nearby offsite spring); and (c) exposures to strontium and uranium pose the greatest risk at the Pit Lake (see also Section 3.5.2).

The presence of elevated concentrations of barium, lead, and strontium in surface water and shallow groundwater (*i.e.*, surrogate surface water) suggest that a possible source may be seepage from the North Tailings Pond. Strontium concentrations in shallow groundwater (< 20 ft bgs) at Roseberry Spring suggest that this seepage has the potential of discharging to the surface at offsite springs.

A cursory examination was conducted for maximum strontium concentrations in (a) groundwater at the background well (MW93-1MW); (b) groundwater at monitoring wells downgradient of the ore fault, but upgradient of the North Tailings Pond (P-16) (*e.g.*, 93-2RMW, 93-4RMW); and (c) surface water and shallow groundwater data at AOCs downgradient of the North Tailings Pond (P-16) (Table 3-27). The general pattern is that concentrations of strontium are much lower in groundwater monitoring wells likely to be unaffected by seepage from P-16 compared to surface water or shallow groundwater at P-16 and at AOCs downgradient from P-16. Moreover, it appears that concentrations of strontium decreases with increased distance from P-16. The results of this cursory examination suggest that seepage from the North Tailings Pond may influence strontium concentrations in shallow groundwater that discharges at donwngradient onsite springs.

Under the proposed plan, the North Tailings Pond will be closed and reclaimed. A lined East Tailings Pond will be established to handle future tailings processing. Thus, under the proposed plan, seepage of tailings pond water is expected to be eliminated. The elimination of tailings pond seepage will (a) result in the loss of several attractive onsite springs (*e.g.*, Jack Meyer's Pond Spring, 17 Spring) and (b) significantly reduce COPC exposures to aquatic and sediment-associated invertebrate communities in nearby, offsite springs (*e.g.*, Roseberry Spring).

The potential reduction in risk by the elimination of seepage is shown in Table 3-13. When strontium and barium concentrations are reduced to background concentrations (based on background groundwater concentrations), risks due to total metals are significantly reduced. However, if seepage is not eliminated, the HQs suggest that aquatic and sediment-associated invertebrates in downgradient springs may be adversely impacted.

The loss of small, intermittent onsite aquatic habitats (and the invertebrate communities they support) is considered to have minimal ecological significance, given the presence of other offsite, intermittent aquatic habitats in nearby washes.

In the future, the Pit Lake is anticipated to provide an attractive aquatic habitat. Based on groundwater data at the Pit Well, aquatic invertebrate communities may be adversely affected by strontium and uranium concentrations in future surface water at the Pit Lake. Whether current groundwater at the Pit Well provides an accurate estimate of future surface water concentrations at the future Pit Lake remains unverified. The degree to which groundwater may over- or underestimate surface water exposures cannot be determined based on existing data (see Section 3.4.1). To reduce uncertainties related to predicted future exposures and risk, characterization and monitoring of the future pit lake may be considered in the EIR.

3.3.2 Potential Risks to Plants

The mine and mill site is dominated by two subassociations of Mojave Desert scrub: Blackbrush-Joshua Tree and Blackbrush-Juniper. Both the western third and undisturbed portions of the central third of the mine and mill site are dominated by blackbrush (*Colegyne ramosissima*) with an overstory of Joshua trees (*Yucca brevifolia*). The eastern third of the mine and mill site is dominated by blackbrush with an overstory of Utah juniper trees (*Juniperus osteoperma*). Both of these subassociations of Mojave Desert scrub are characterized by open, bare ground with scattered assemblages of broad-leaved evergreen or deciduous microphyll shrubs. Blackbrush is the dominant plant in the shrub layer. Conspicuous plant species also include Mojave yucca (*Yucca schidigera*), desert squaw-bush (*Rhus trilobata*), calico cactus (*Echinocereus engelmannii*), beavertail cactus (*Opuntia basilaris*), barrel cactus (*Ferocactus cylindraceus*), buckhorn cholla (*Opuntia acanthocarpa*), four-wing saltbush (*Atriplex canescens*), desert agave (*Agave deserti*), big galleta grass (*Pleuraphis rigida*), and desert primrose (*Oenothera brevipes*).

The central third of the mine and mill site supports much of the mine and mill buildings and roads. These areas are characterized by either the lack of vegetation or the presence of sparse patches of highly disturbed, introduced plant species. This habitat type provides little or no attractive refuge or foraging habitat compared to surrounding, minimally disturbed desert habitats.

For the most part, drainages and washes at the mine and mill site support desert scrub vegetation. However, riparian vegetation is observed in drainages and washes downgradient from developed water impoundments. Plants commonly observed in desert wash include tamarisk, mesquite, desert broom, desert willow, and desert acacia. Groundcover consists of a variety of grasses and forbs.

Plants provide refuge, foraging habitat, and a source of food for herbivorous wildlife. Plant communities play an essential role in the structure and function of desert communities. Risks to plants were assessed at the community-level.

Hazard Quotients. HQs calculated for plants are provided in Tables 3-15 to 3-16. HQs (color-coded according to relative risks) suggest that:

Shallow-Rooted Plant Communities

1. Concentrations of metals (in particular, lead, molybdenum, and strontium) in surface soils pose a potential risk at the Overburden Stockpile, Windblown Tailings, onsite ponds, and onsite intermittent springs (see Table 3-15).
2. To a lesser degree than other onsite AOCs, concentrations of metals in surface soils pose a potential risk at Wheaton Wash/ Roseberry Spring and the North Tailings Pond (see Table 3-16).
3. Concentrations of metals (in particular, lead and strontium) in surface soils pose a potential future risk at the Pit Lake and East Tailings Pond.
4. Conversely, radionuclides in surface soils pose a negligible risk.

Deep-Rooted Plant Communities

5. Arsenic and lead in shallow groundwater at intermittent onsite springs poses a potential risk.
6. Conversely, metals in shallow groundwater at Wheaton Wash and the future Pit Lake pose a negligible risk.
7. In addition, radionuclides in shallow groundwater at intermittent springs pose a negligible risk.

The lack of phytoxicity data hampers assessment of risk to plants due to exposure to lanthanide metals in soils and shallow groundwater. However, existing studies indicate that plants discriminate against lanthanide absorption by the roots (Venugopal and Luckey 1978).

Presence of Threatened or Endangered Species. No threatened or endangered plants have been reported at the mine and mill site (Lilburn 1990-1996; Dames & Moore 2000b).

Quality of Potentially Affected Habitats. Based on visual observations, stressed vegetation[9] was observed at the Overburden Stockpile, at the Windblown Tailings, in the North Tailings Pond, in the Seepage Collection Ponds, and immediately surrounding developed water impoundments at the mine and mill site. The cause of stressed vegetation at the

[9] Qualitative evaluations of vegetation were based on visual observations performed during the June 1999 sampling effort. Stressed vegetation was determined based on qualitative evaluation of sparse, often stunted vegetation at AOCs compared to observations of vegetation dominating nearby areas.

Overburden Stockpile and the area immediately surrounding developed water impoundments may have little to do with COPC concentrations in soils since these areas are subject to a high degree of physical disturbance (*e.g.*, erosion of top soil, compaction of top soil, trampling) due to human and vehicular traffic. No overt visual signs of stressed vegetation were observed at reference background locations (Figure 3-5), at offsite springs (*i.e.*, Wheaton Wash/Rosberry Spring) (Figure 3-6), and in undisturbed areas surrounding developed water impoundments (Figure 3-7).

Of note, the Overburden Stockpile provides little or no attractive habitat (Figure 3-8). Steep slopes, boulders/large rocks, little topsoil, and hard-packed dirt roads characterize this AOC. With the exception of the occasional weed, no other vegetation was observed at the Overburden Stockpile during the recent field sampling effort (Tetra Tech 2000a). Given the terrain, substrate, and constant use, this AOC is unlikely to support plant communities in the near future without an active restoration effort.

Similarly, the Windblown Tailings AOC provides little or no attractive habitat. Deep, fine sands have buried most of the vegetation—only the occasional yucca or coyotebush were visible during the field sampling effort (Figure 3-9). Given the terrain and substrate, this area was considered to be unsuitable to support a Joshua tree-blackbrush desert scrub community without an active restoration effort.

No mine and mill site AOCs are located in critical wildlife management areas or wildlife refuges. However, habitats at or near most AOCs are capable of supporting desert tortoise populations.

Potential for Recovery. Research indicates that succession in desert plant communities is a very long process (Rundel and Gibson 1996). Studies examining natural plant recolonization of ghost towns, abandoned military encampments, utility corridors, plowed fields, and burrow pits in the Mojave Desert indicate that seedlings of short-lived shrubs, suffrutescent perennials, white bursage, and teddy bear cholla may naturally re-establish within 30-40 years. Large-scale recruitment of longer-lived species (*e.g.*, creosotebush) may take much longer (Vasek 1979). Once established, desert scrub habitats proceed slowly from seedlings to mature plants (Mayer and Laudenslayer 1988). Existing research suggests that complete recovery from disturbance is likely to take well over 60 years for desert scrub habitats (Wells 1961, Webb and Wilshire 1980, Carpenter *et al.* 1986).

Joshua trees and junipers are slow growers (Tueller and Clark 1975). Studies of plowed fields in the Mojave Desert have shown that Joshua Tree woodland did not recover in a 65-year time period (Carpenter *et al.* 1986).

Introduced plants (*e.g.*, brome) are not only colonizers but may outcompete native plants in desert scrub habitats, thereby changing the composition of the annual flora (Rundel and Gibson 1996). The result of natural recolonization may be a collection of plants that are not similar to the composition of the original native community. Of note, the success of desert tortoise populations, their energy and water budgets, as well as reproductive capacity, depends very strongly on the success of native desert annuals (Rundel and Gibson 1996). Thus, the long-term recovery of plant communities can have a resultant long-term impact on wildlife that require plants (in some cases specific native plants) for food, refuge, or breeding habitat.

Potential for and Ecological Significance of Adverse Impacts. The HQs suggest that elevated metal concentrations in soils at all AOCs pose a potential risk to plant communities. Analyses of relative risks suggest that exposures to lead, molybdenum, and strontium pose the greatest risk to plant communities and that the greatest risk to plant communities occurs at the Seepage Collection Pond and Overburden Stockpile. Relative risks tend to diminish with distance from these onsite areas (see Section 3.5.2). Based on relative risks, COPCs in soils at the North Tailings Pond and Wheaton Wash/Roseberry Spring pose comparatively less risk to plant communities.

Risks to shallow-rooted plant communities at the Administration Pond, Jack Meyer's Pond Spring, and 17 Spring may be overestimated. At these aquatic habitat AOCs, sediments served as surrogate surface soils. Sediments typically have greater organic content and are finer-grained compared to soils, and, therefore, tend to more readily sorb metals. The degree to which sediment may overestimate surface soil exposures cannot be determined based on existing data (USEPA 1992d) (see Section 3.4.1).

Unless future reclamation efforts are performed, risks to plants at developed water impoundments and onsite intermittent springs immediately downgradient of the North Tailings Pond will remain. Given the proposed plan, risks to plant communities are also likely to exist at the future Pit Lake and East Tailings Pond[10]. Risk estimates for the North Tailings Pond suggest that if future off-site transport of windblown tailings is effectively controlled, risks to plants can be significantly reduced.

3.3.3 Potential Risks to Soil Invertebrates

Invertebrate are, by far, the most abundant animals in arid regions (Crawford 1986). Soil invertebrate communities consist of isopods, arachnids, centipedes and millipedes, and insects. Members of the soil invertebrate community perform key functions in desert ecosystems—soil invertebrates are predators, scavengers, detritivores, pollinators, and a source of food for insectivorous wildlife. Risks to soil invertebrates were assessed at the community-level.

Hazard Quotients. HQs calculated for soil invertebrates are provided in Table 3-17. HQs (color-coded according to relative risks) suggest that:

Soil Invertebrate Communities

1. Concentrations of barium, lead, and lanthanide metals in soils pose a risk at the Overburden Stockpile, Windblown Tailings, Seepage Collection Pond, Lanthanide Storage Ponds, and future Pit Lake, and to a lesser degree, at other onsite AOCs.
2. By comparison, a negligible potential for risk exists at the North Tailings Pond and Wheaton Wash/Roseberry Spring.
3. Radionuclides in surface soils pose a risk to soil invertebrate communities only at the Seepage Collection Pond and Lanthanide Storage Ponds.

Presence of Threatened or Endangered Species. No threatened or endangered soil invertebrates have been reported at the mine and mill site (Lilburn 1990-1996; Dames & Moore 2000b).

Quality of Potentially Affected Habitats. Based on visual observations, developed/ industrial areas of the mine and mill site provide marginal habitat for soil invertebrate communities (Figure 3-10). These areas exhibit a high degree of physical disturbance due to human traffic (*e.g.*, roads). Minimally disturbed habitat was observed at reference background locations (Figure 3-5) and in areas further than 100 yards from onsite AOCs (Figure 3-7).

In particular, the Overburden Stockpile provides little or no attractive habitat. Steep slopes, boulders, large rocks, and hard-packed dirt roads found at this AOC are unlikely to support a diverse or abundant soil invertebrate community compared to undisturbed desert habitat. However, some members of the soil invertebrate community (*e.g.,* beetles) are highly robust and may be some of the only animals able to make a meager living in this harsh physical environment.

Similarly, the Windblown Tailings AOC provides little or no attractive habitat. Deep, fine sands and the lack of vegetation were considered to provide poor/marginal habitat.

Potential for Recovery. Soil invertebrates, especially insects, are known for their resiliency and ability to successfully immigrate and establish in harsh environments (Barnes 1980).

[10] For the future expansion scenario, the North Tailings Pond/Windblown Tailings served as a surrogate AOC for the East Tailings.

Given their relatively high fecundity and short generation times, insects are known for quickly adapting to unusual chemical regimes. As a result, recovery from disturbance is likely to be more rapid compared to other desert receptors (Rundel and Gibson 1996; Crawford 1981, Barnes 1980).

Potential for and Ecological Significance of Adverse Impacts. HQs suggest that elevated barium, lead, and lanthanide metal concentrations in soils pose a potential risk to soil invertebrate communities at all onsite AOCs. Analyses of relative risks suggest that exposures to lanthanide metals pose the greatest risk to soil invertebrate communities and that soil invertebrate communities are at greatest risk at the Lanthanide Storage Ponds. Relative risks tend to diminish with distance from this onsite AOC (see Section 3.5.2). Based on relative risks, COPCs in soils at the North Tailings Pond and Wheaton Wash/Roseberry Spring pose comparatively less risk to soil invertebrate communities.

Risks to soil invertebrate communities at the Administration Pond, Jack Meyer's Pond Spring, and 17 Spring may be overestimated. At these aquatic habitat AOCs, sediments served as surrogate surface soils. In general, sediments tend to have higher concentrations than soils because metals are more easily sorbed onto small grain, high organic carbon-content sediment surfaces (USEPA 1992d). The degree to which sediment may overestimate surface soil exposures cannot be determined based on existing data (USEPA 1992d) (see Section 3.4.1).

Unless future reclamation efforts are performed, risks to soil invertebrates at the Overburden Stockpile, Windblown Tailings, Seepage Collection Pond, and Lanthanide Storage Ponds will remain. Given the proposed plan, risks to soil invertebrate communities are also likely to exist at the future Pit Lake and East Tailings Pond[11]. Risk estimates for the North Tailings Pond suggest that if future off-site transport of windblown tailings is effectively controlled at the East Tailings Pond, risks to soil invertebrates can be significantly reduced.

[11] For the future expansion scenario, the North Tailings Pond/Windblown Tailings served as a surrogate AOC for the East Tailings.

3.3.4 Potential Risks to the Desert Tortoise and Other Reptiles

Reptiles, especially lizards and snakes, are diverse and abundant in deserts (Brown 1986). Being ectothermic (*i.e.*, body temperature varies with environmental temperature), reptiles have much lower energy requirements than those of birds and mammals, which maintain high, constant body temperatures (*i.e.*, endothermic). Reptiles are physiologically more efficient than endotherms in that a much larger proportion of the food they consume is incorporated into biomass. In addition, a habitat or food source that could sustain only a small population of birds or mammals can support a much larger population of reptiles. Lastly, reptiles can go dormant and survive for many months without eating, which is advantageous in episodic, low production habitats (Brown 1986).

The desert tortoise is listed as a threatened species under the Endangered Species Act (ESA) and, as such, is a receptor of particular interest at the mine and mill site. The desert tortoise is an important herbivore in arid land habitats—due to its large size and local abundance, the desert tortoise can contribute a significant proportion of the biomass and energy turnover in the desert scrub community in the Mojave Desert (Bury 1982). The desert tortoise has been observed in almost every desert habitat, except on the most precipitous slopes (Zeiner *et al*. 1988). The success of desert tortoise populations, their energy and water budgets, as well as reproductive capacity, depends very strongly on the success of native desert annuals (Rundel and Gibson 1996) (see Section 3.3.2).

Risks to the desert tortoise were assessed at the individual-level.

Hazard Quotients. While the pervasive approach in ERAs is the protection of the population, this perspective was modified in this ERA for the desert tortoise, which is protected by law under the Endangered Species Act (ESA). While no specific guidance exists on uncertainty factors for endangered/threatened species, before being used to calculate risk estimates for the desert tortoise, avian RTVs were adjusted by dividing by a factor of 20 to (1) account for the extrapolation of RTVs from birds to reptiles and (2) ensure protective risk estimates for a federally listed threatened species. Application of a 20-fold uncertainty (safety) factor is consistent with the approach for evaluating risk to susceptible subgroups within human populations, is consistent with suggestions provided by Calabrese and Baldwin (1993), and was considered to provide an added margin of safety for the desert tortoise. For further details, see Section T5.8.2 of Appendix I.

HQs calculated for the desert tortoise are provided in Table 3-18. HQs (color-coded according to relative risks) suggest that:

1. For the vast majority of COPCs, concentrations at mine and mill site AOCs pose a negligible potential for risk to the desert tortoise.
2. Concentrations of lead at the Overburden Stockpile, Windblown Tailings, Seepage Collection Ponds, future Pit Lake, and future East Tailings Pond may pose a potential risk to the desert tortoise.
3. Radionuclides pose a risk at the Seepage Collection Pond and Lanthanide Storage Ponds.
4. A negligible potential for risk exists at Wheaton Wash/ Roseberry Spring and at the North Tailings Pond.
5. Risks due to exposures to lanthanide metals could not be evaluated due to the lack of toxicity data.

Presence of Threatened or Endangered Species. Desert tortoises have been observed in a variety of desert habitats in the United States. In general, the desert tortoise is found below the 4,000 foot above mean sea level elevation in tree-yucca (Joshua tree and Mojave yucca) communities, creosote bush and saltbush scrub habitats, and in some ocotillo-creosote habitats (Berry 1990). To maintain successful populations, the desert tortoise must have suitable soils and terrain for constructing a burrow and must have sufficient herbaceous or succulent plants in the spring and/or summer for forage (Rundel and Gibson 1996).

Most of the mine and mill site occurs at elevations in the range of 4,600 to 4,900 feet above mean sea level (Lilburn Corporation 1991). At this elevation, the mine and mill site is located at an extreme end of the desert tortoise's elevation range.

A single desert tortoise has been observed offsite, on the west side of the mine and mill site boundary. Tortoise exclusion fences have been established along this western boundary to prevent desert tortoise access to the mine and mill site. Furthermore, Molycorp has conducted several desert tortoise surveys at the mine and mill site over the last ten years to track the occurrence and location of desert tortoises at the mine and mill site (Lilburn 1990-1996; Dames & Moore 2000b).

No desert tortoises have been observed at any mine and mill site AOC. However, to ensure a conservative assessment of risk to the desert tortoise, all mine and mill AOCs (except the Overburden Stockpile) were considered to support suitable desert tortoise habitats. Thus, potential risks to the desert tortoise at mine and mill site AOCs are purely hypothetical and are intended to support planning issues addressed in the EIR.

No other threatened or endangered reptiles have been observed at the mine and mill site (Lilburn 1990-1996; Dames & Moore 2000b).

Quality of Potentially Affected Habitats. Onsite ponds were considered to be attractive to the desert tortoise (and other reptiles) seeking a source of drinking water. Moreover, the North Tailings Pond (P-16) and Sewage Treatment Pond (P-19) were considered to provide attractive desert scrub habitat as well. In contrast, only poor/marginal desert scrub habitat was observed at the Seepage Collection Ponds (P-23) (Figure 3-11), and the Lanthanide

Storage Ponds (P-25b, P-28) provided little or no attractive habitat (Figure 3-12).

To ensure a protective assessment of risk, lanthanide product exposed at the Lanthanide Storage Ponds (P25b, P-28) was sampled and used to represent soil exposures. Therefore, at this developed water impoundment, exposures are to product and not to surrounding soils, as is the case at other developed water impoundments. Consequently, risks at the Lanthanide Storage Ponds are likely to represent maximum exposures to lanthanide metals, as well as other metals and radionuclides that are associated with product.

The Overburden Stockpile and the windblown tailings AOCs provides little or no attractive habitat (see Section 3.3.2). Given conditions during the June 1999 field sampling effort, these AOC are unlikely to support desert tortoise populations in the near future without an active habitat restoration effort.

Potential for Recovery. Typically, species that grow slowly, reach sexual maturity at a late age, produce few offspring per year, and do not migrate much will require a significant amount of time to recover from a disturbance. Accordingly, desert tortoise populations will require a significant amount of time to recover from disturbance. Potential risks to these receptors are of particular ecological significance.

Potential for and Ecological Significance of Adverse Impacts. HQs suggest that, for the vast majority of COPCs, concentrations at mine and mill site AOCs pose a negligible potential for risk to the desert tortoise (and other reptile populations). Only exposures to lead at the Overburden Stockpile, Windblown Tailings, Seepage Collection Pond, and future Pit Lake and selenium at the Lanthanide Storage Ponds pose a potential risk to the desert tortoise. However, these HQs only slightly exceed the highest dose at which no adverse effects were observed (maximum HQ for lead = 4.5; maximum HQ for selenium = 1.3).

The greatest relative risks were found at the Overburden Stockpile and Lanthanide Storage Ponds—relative risks tend to diminish with distance from these onsite areas. In fact, exposures to COPCs at Wheaton Wash/Roseberry Springs pose a negligible risk to desert wildlife (see Section 3.5.2).

Unless future reclamation efforts are performed, risks to the desert tortoise at the Lanthanide Storage Ponds and Overburden Stockpile will remain. Given the proposed plan, the future Pit Lake and East Tailings Pond will provide attractive habitat to the desert tortoise. HQs at these future AOCs suggest that lead in soils poses a potential risk to the desert tortoise. For the future expansion scenario, the North Tailings Pond/Windblown Tailings served as a surrogate AOC for the East Tailings. Risk estimates for the North Tailings Pond suggest that if future off-site transport of windblown tailings is effectively controlled, risks to the desert tortoise can be significantly reduced at the East Tailings Pond.

The lack of toxicity data for lanthanide metals severely hampers assessments of risk for the desert tortoise at mine and mill site AOCs. Uncertainties associated with the lack of toxicity data for reptiles and lanthanide metals are discussed in Section 3.4.2.

3.3.5 Potential Risks to Avian and Mammalian Wildlife

Desert scrub habitats support few resident bird populations unless permanent water is available (Serventy 1971). However, unlike other groups of desert vertebrates, relatively few birds are restricted to desert habitats. The vast majority of desert birds must have high, relatively constant rates of food intake throughout the year (Brown 1986). Some desert birds can reduce energy expenditures by dropping their body temperature near ambient levels at night when they are inactive. The ability to fly enables birds to avoid the problems of meeting their high energy requirements. Many birds are not permanent residents, but migrate through the desert when sufficient food is available.

Mammals are remarkably abundant in deserts given that they lack both the energy efficiency of ecothermy and the tremendous mobility of birds (Brown 1986). During the day in the Mojave Desert scrub, mammals are infrequently seen, but at night they emerge to forage (Rundel and Gibson 1996). Chief among the mammals are the small fossorial rodents. A trait that is key to the success of mammals in desert habitats is their sophisticated foraging behavior (Brown 1986).

In general, yearly variability in desert bird and mammal populations is highly dependent on climatic factors (Rundel and Gibson 1996). It should also be noted that although of particular interest to humans, vertebrates represent a small portion of the number of individuals, biomass, energy flow, and material transfer in the desert ecosystem—on the order of one percent of the total for the ecosystem (Brown 1986).

For the mine and mill site, avian and mammalian wildlife receptors include:

- Waterfowl
- Herbivorous, insectivorous, and carnivorous birds
- Herbivorous, insectivorous, and carnivorous mammals

Hazard Quotients. HQs calculated for wildlife are provided in Tables 3-19 to 3-26. HQs (color-coded according to relative risks) suggest that:

Waterfowl Populations (Table 3-19)

1. Barium, lead, selenium, vanadium, and zinc at onsite ponds pose a potential risk (relative risk < 5) to waterfowl.
2. Radionuclides at the Seepage Collection Pond, Lanthanide Storage Ponds, Administration Pond, and the future Pit Lake pose a potential risk to waterfowl.
3. Risks due to exposures to lanthanide metals could not be evaluated due to the lack of avian toxicity data.

Herbivorous, Insectivorous, & Carnivorous Bird Populations (Table 3-20 to 3-22)

4. Concentrations of lead (and to a lesser degree, barium, selenium, vanadium) at the Seepage Collection Pond (and, to a lesser degree, at other onsite AOCs) pose a potential risk to herbivorous birds.
5. Conversely, concentrations of metals at the North Tailings Pond and Wheaton Wash/Roseberry Spring pose a negligible risk to herbivorous birds.
6. Radionuclides at the Seepage Collection Ponds pose a potential risk to herbivorous birds.
7. Concentrations of lead (and, to a lesser degree, barium, cadmium, chromium, mercury, molybdenum, copper, selenium, vanadium, zinc) at the Overburden Stockpile, Windblown Tailings, Seepage Collection Ponds, and future Pit Lake pose a potential risk to insectivorous birds.
8. Conversely, concentrations of metals at the North Tailings Pond pose a negligible risk to insectivorous birds.
9. Radionuclides at the Lanthanide Storage Ponds, Seepage Collection Pond, Overburden Stockpile (and, to a lesser degree, Windblown Tailings, Sewage Treatment Pond, Administration Pond, 17 Spring, Jack Meyer's Pond Spring, future East Tailings Pond) pose a potential risk to insectivorous birds.
10. Concentrations of chromium, lead, and zinc (relative risks < 5) in soils pose a potential risk to carnivorous birds.
11. Radionuclides were not evaluated for carnivorous birds at mine and mill site AOCs. Based on risks to herbivorous and insectivorous bird and limited time spent on the ground at AOCs, it may be inferred that radionuclides are unlikely to pose a potential risk to carnivorous birds.
12. Risks due to exposures to lanthanide metals could not be evaluated due to the lack of avian toxicity data.

Herbivorous, Insectivorous, & Carnivorous Mammal Populations (Table 3-23 to 3-26)

13. Concentrations of several metals (notably lead and strontium) pose a potential risk to herbivorous mammals. Exposures at the Lanthanide Storage Ponds and, to a lesser extent at the Overburden Stockpile, Windblown Tailings, Seepage Collection Ponds, future Pit Lake, and future East Tailings Pond pose the greatest potential risk to herbivorous mammals.
14. In particular, concentrations of yttrium and lanthanide metals pose a potential risk to herbivorous mammals at the Lanthanide Storage Ponds.
15. Radionuclides at the Seepage Collection Ponds, Lanthanide Storage Ponds, and future Pit Lake pose a potential risk to herbivorous mammals.
16. Conversely, metal, lanthanide metal, and radionuclide concentrations pose a negligible risk to herbivorous mammals at Wheaton Wash/Roseberry Spring.
17. Concentrations of antimony, lead, and molybdenum pose a potential risk to insectivorous mammals. Exposures at the Overburden Stockpile, Windblown Tailings, Seepage Collection Ponds, and Lanthanide Storage Ponds pose the greatest potential risk to insectivorous mammals.
18. In particular, concentrations of yttrium and lanthanide metals pose a potential risk to insectivorous mammals at the Lanthanide Storage Ponds.
19. Radionuclides at the Overburden Stockpile, Seepage Collection Pond, Lanthanide Storage Ponds, (and, to a lesser degree, Windblown Tailings, Administration Pond, 17 Spring, Jack Meyer's Pond Spring, future Pit Lake, and future East Tailings Pond) pose a potential risk to insectivorous mammals.
20. Conversely, metal, lanthanide metal, and radionuclide concentrations pose a negligible risk to insectivorous mammals at Wheaton Wash/Roseberry Spring.
21. Concentrations of lanthanide metals (and, to a lesser degree, barium and strontium) pose a potential risk to far-ranging herbivorous and carnivorous mammals.
22. Radionuclides were not evaluated for carnivorous mammals at mine and mill site AOCs. Based on risks to herbivorous and insectivorous mammals and limited time spent on the ground at AOCs, it is unclear whether radionuclides pose a potential risk to carnivorous mammals.

The following AOCs pose the greatest risks to birds and mammals:

- Lanthanide Storage Ponds
- Seepage Collection Ponds
- Overburden stockpile
- Windblown tailings

For the most part, exposures to lead at these AOCs posed a risk to both birds and mammals.

Lanthanide metals at the Lanthanide Storage Ponds pose the greatest risk to mammalian wildlife—risk to birds could not be evaluated for lanthanide metals due to the lack of relevant avian toxicity data. To a lesser degree, antimony, barium, strontium, and molybdenum posed a potential risk to mammalian wildlife populations at mine and mill site AOCs. Exposures to lanthanide metals (in particular, lanthanum) pose the greatest risk to far-ranging herbivorous and carnivorous mammals.

Exposures to far-ranging mammals may be overestimated because these animals are assumed to obtain all their drinking water from the mine and mill site. For example, drinking water (DrW) represents over 70 percent of the total lanthanum exposure for the bighorn sheep and over 90 percent of the total lanthanum exposure for the coyote.

LANTHANUM

	Bighorn Sheep	Coyote
DrW Exposure	41 mg/kg-d	18 mg/kg-d
Total Exposure	57 mg/kg-d	20 mg/kg-d
Exposure w/o DrW	16 mg/kg-d	2 mg/kg-d

Therefore, if access to the Lanthanide Storage Ponds and North Tailings Pond were restricted, risks to wildlife could be significantly reduced.

Presence of Threatened or Endangered Species. No threatened or endangered birds or mammals have been reported at the mine and mill site (Lilburn 1990-1996; Dames & Moore 2000b).

Given the broad definition, nearly all birds observed in California are protected under the Migratory Bird Treaty Act. Two birds observed at the site are listed as California Species of Special Concern: Le Conte's thrasher and the loggerhead shrike.

- One Le Conte's thrasher was observed in the area proposed for the northwest evaporation pond facility (Dames & Moore 2000b). Sheppard (1996) reported that there have been no significant changes in local populations and 1.3 million acres of this species' range in California has been dedicated for conservation and management.
- Loggerhead shrikes are observed along roads and on fences at the mine and mill site (Lilburn 1990-1996; Dames & Moore 2000b). This species is commonly observed in San Bernardino County.

Several bats are listed as California Species of Special Concern: pallid bat, California leaf-nose bat, pale big-eared bat, California western mastiff bat, Yuma myotis, and the spotted bat. These bats may forage in desert scrub and at water impoundments. No roosting habitats (*e.g.*, caves, rock crevices) are found at mine and mill site AOCs.

Quality of Potentially Affected Habitats. No mine and mill site AOCs are located in critical wildlife management areas or wildlife refuges.

Onsite ponds were considered to be attractive to wildlife seeking a source of drinking water. Moreover, the North Tailings Pond (P-16) and Sewage Treatment Pond (P-19) were considered to provide attractive desert scrub habitat as well. In contrast, only marginal desert scrub habitat was observed at the Seepage Collection Ponds (P-23); while, the Lanthanide Storage Ponds (P-25b, P-28) provided little or no attractive habitat.

To ensure a protective assessment of risk, lanthanide product exposed at the Lanthanide Storage Ponds (P25b, P-28) was sampled and used to represent soil exposures. Therefore, at this developed water impoundment, wildlife exposures are to product and not surrounding soils, as is the case at other developed water impoundments. Consequently, risks at the Lanthanide Storage Ponds are likely to represent maximum exposures to lanthanide metals, as well as other metals and radionuclides that are associated with product.

The Overburden Stockpile and the Windblown Tailings AOCs provides little or no attractive habitat (see Section 3.3.2). Given conditions during the June 1999 field sampling effort, these AOCs are unlikely to support wildlife populations in the near future without an active habitat restoration effort.

Potential for Recovery. Some bird populations (most notably raptors) produce few viable offspring per year and are likely to recover slowly following severe impacts to their populations. Potential risks to these receptors are of particular ecological significance.

Small mammal populations have a greater potential for recovering quickly given their early sexual maturity, short gestation time, and large broods. However, recovery of wildlife populations will be influenced by the severity of impacts to their habitat (*i.e.*, vegetation) and prey populations. Desert communities are noted for their slow recovery time (Mayer and Laudenslayer 1988).

Potential for and Ecological Significance of Adverse Impacts. HQs suggest that exposures to metals and lanthanide metals at all AOCs pose a potential risk to wildlife populations. Analyses of relative risks suggest that exposures to lanthanide metals pose the greatest risk to wildlife populations and that wildlife populations are at greatest risk at the Lanthanide

Storage Ponds, Seepage Collection Pond, and Windblown Tailings. Relative risks tend to diminish with distance from these onsite areas (see Section 3.5.2). Based on relative risks, exposures to metals and lanthanide metals at Wheaton Wash/Roseberry Spring, a nearby offsite AOC, pose a negligible risk to desert wildlife (see Section 3.5.2).

Unless future reclamation efforts are performed, risks to wildlife populations at the Lanthanide Storage Ponds, Seepage Collection Pond, and Windblown Tailings will remain. In particular, until access to the Lanthanide Storage Ponds and North Tailings is restricted, risks to wildlife (especially, large far-ranging wildlife) will remain. Given the proposed plan, risks to wildlife populations are also likely to exist at the future Pit Lake and East Tailings Pond. For the future expansion scenario, the North Tailings Pond/Windblown Tailings served as a surrogate AOC for the East Tailings. Risk estimates for the North Tailings Pond suggest that if future off-site transport of windblown tailings is effectively controlled, risks to wildlife populations can be significantly reduced.

3.4 UNCERTAINTY ANALYSIS

The uncertainty analysis identifies the key assumptions and data gaps associated with the analyses performed. There are three major types of uncertainties in the risk assessment: (1) variability, (2) uncertainty of the true value (*i.e.*, measurement error), and (3) data gaps (USEPA 1998b). Topics included in this uncertainty analysis address all three types of uncertainties.

The approach used in this ERA for the mine and mill site is designed to mitigate the effects of uncertainties that may result in underestimation of risks. To ensure that risk estimates are protective:

- The U.S. Fish and Wildlife Service, California Fish and Game, Bureau of Land Management, and National Parks Service reviewed species lists to reduce the possibility of omitting key receptors of concern.
- Estimates of COPC concentrations in media are based on samples collected from known or suspected impacted areas of each AOC.
- Wildlife indicator species were selected based on attributes that tended to provide conservative estimates of exposure for other members of the guild.
- Estimates of exposure assume that wildlife obtain all of their drinking water from mine and mill site AOCs.
- Estimates of exposure assume that wildlife do not avoid contaminated areas or foods.
- Reproductive or developmental effects are among the most sensitive of test endpoints and were the preferred endpoints when selecting toxicity studies.
- Chronic no observable adverse effect levels (NOAEL)-equivalent RTVs are used to characterize toxic doses.
- All methods and data used in the risk were reviewed by the Technical Work Group to ensure a protective assessment.

Key uncertainties identified for the mine and mill site ERA are described below.

3.4.1 Uncertainties in the Exposure Assessment

Site-specific sources of uncertainty related to COPC exposures include:

- Use of indicator species
- Site presence index
- Bioaccumulation factors
- Omission of dermal contact
- Surrogate exposure data
- Future exposures

Use of Indicator Species. Indicator species were used to infer the potential for adverse impacts to taxonomically and functionally related receptors of concern. Very little is known about the relative sensitivity to metals, lanthanide metals, uranium, and radionuclides among related species. Therefore, the extrapolation of risks from species to species introduces an unquantifiable amount of uncertainty.

To minimize the chance of underestimating risk, indicator species were selected to maximize estimates of exposure (*e.g.*, small body size, small home or foraging ranges, forages on ground surface), where possible. To minimize extrapolations (and the uncertainties they introduce) for the only threatened or endangered species observed at the mine and mill site, the desert tortoise was selected as the indicator reptilian wildlife species.

Site Presence Index. The site presence index is the ratio of the AOC area to the foraging area of a given receptor and was used to estimate the fraction of time that a receptor is likely to spend at a particular AOC. The boundary of most mine and mill site AOCs were difficult to determine accurately. Assumed AOC areas used in this screening-level ERA conservatively encompasses identified potentially affected areas and results in a site presence index of one for terrestrial wildlife indicator species, except for the far-ranging species.

Similarly, it is difficult to accurately quantify the fraction of time a receptor is likely to drink from a surface water body. To ensure a protective screening-level ERA, it is assumed that receptors obtain all their drinking water from surface water bodies at an AOC.

Site presence indices used in this screening-level ERA are likely to overestimate estimates of risk.

Bioaccumulation Factors. To evaluate the influence of modeled bioaccumulation, tissue concentrations derived using the log-linear regression models were compared to soil concentrations (*i.e.*, tissue concentration/soil concentration). Log-linear regression models for plants and invertebrates did not produce unusually high or low tissue burdens based on comparisons to results of field studies (Sample *et al.* 1998ab, Bechtel Jacobs LLC 1998ab, Alsop *et al*. 1996). Similarly, log-linear regression models for small mammals did not produce unusually high or low tissue burdens relative to soil concentrations. However, tissue burdens based on log-linear regression models were high relative to tissue burdens based on point estimate bioaccumulation factors. Whether log-linear regression models and point estimate bioaccumulation factors are reasonable predictors of bioaccumulation in desert plant, invertebrate, and small mammal tissues has not been verified. To more adequately model ingestion exposures to these receptors, site-specific analyses of tissue burdens in plants and invertebrates may be considered.

Omission of Dermal Contact. Exposure due to dermal contact was considered insignificant and was not quantitatively evaluated in the ERA (see Section 3.1.4). To further support the proposition that dermal contact is a relatively minor exposure route, an example calculation of dermal risks to the desert kangaroo rat exposed to lead in soils at the Windblown Tailings AOCs is provided in Table 3-28. In accordance with USEPA (1992a, 1993) guidance, the formula used to calculate dermal exposure is:

$$\text{External Dermal Exposure (mg/kg)} = \frac{C_s \times CF \times SA \times AF \times SPI}{BW}$$

where:

- C_s = Chemical soil concentration (mg/kg)
- CF = Conversion factor (10^{-6} kg/mg soil)
- SA = Dermal surface area (cm^2)
- AF = Soil-skin adherence factor (1 mg/cm^2)
- SPI = Site presence index (= 1)
- BW = Body weight (kg)

To provide a protective estimate, it was assumed that 100% of the skin surface area is in contact with adhering soil. The dermal RTV for lead was developed from available toxicity benchmarks for tetraethyl lead (Lewis 1992). Use of a dermal RTV for lead that was derived from tetraethyl lead is considered conservative, since organometals cross biological membranes more readily and are more toxic than inorganic lead (Eisler 1988).

In this example, dermal contact to lead was only 2.2 percent of the risk due to ingestion. In general, results of dermal risk calculations indicate that the dermal exposure route is minor relative to the ingestion pathway, typically comprising less than 5% of the risk due to ingestion for a given chemical. Therefore, the omission of dermal contact is likely to have a negligible effect on conclusions reached in the ERA.

Surrogate Exposure Data. Due to the lack of surface water during the field sampling effort, aquatic exposures at Wheaton Wash/Roseberry Spring and the future Pit Lake are based on data from shallow groundwater monitoring wells. The rationale is that shallow groundwater discharges to the surface at Roseberry Spring during and immediately following the wet season. Similarly, it is assumed that nearby, upgradient groundwater will be the source of the Pit Lake water and provide a reasonable estimate of future surface water exposures. However, whether shallow groundwater provides an accurate estimate of surface water concentrations at Roseberry Spring or the future Pit Lake remains unverified.

Risks to plants, soil invertebrates, and wildlife at the Administration Pond, Jack Meyer's Pond Spring, and 17 Spring may be overestimated. No surface soils were collected at these aquatic habitats; instead, sediments served as surrogate surface soils. Exposures at these aquatic habitat AOCs were based on metal, lanthanide metal, thorium, uranium, and radionuclide concentrations in sediments. In general, sediments tend to have higher contaminant concentrations than soils because chemicals are more easily sorbed onto small grain, high organic carbon-content sediment surfaces (USEPA 1992d). The degree to which sediment may overestimate surface soil exposures cannot be determined based on existing data.

Future Exposures. For most future AOCs, future exposures were based on baseline scenario conditions at a similar (or the same) AOC (see Table 3-1). Thus, for the most part, exposures under the future expansion scenario are similar to the baseline scenario with the following exceptions:

- North Tailings Pond will be closed and reclaimed—a lined East Tailings Pond will be established to handle future tailings processing
- Loss of several onsite springs due to elimination of seepage from the North Tailings Ponds
- Construction of onsite evaporation ponds
- Formation of Pit Lake at the open pit mine

The degree to which current conditions are good predictors of the future cannot be verified. However, current conditions at most onsite AOCs are already a result of long-term use and practices at the mine and mill site. Therefore, it is reasonable to assume that at most AOCs, future COPC concentrations will not be drastically different from current concentrations (unless concentrations in the source change).

Future Overburden Stockpile. Though future concentrations in soils may not change substantially from current conditions at the Overburden Stockpile, the area of this AOC is predicted to triple. Thus, exposures over a larger area are anticipated. It should be noted that the HQs calculated for the Overburden Stockpile have assumed that indicator species (except for the far-ranging species) spend 100 percent of their time onsite.

Future Onsite Evaporation Ponds. Exposures at the proposed future onsite evaporation ponds were predicted using models (see Section 3.2.1). To ensure a protective ERA, predicted concentrations for surface water and solids at the onsite evaporation ponds assumed no treatment of the wastestream prior to entering the onsite evaporation ponds and that wildlife exposures occurred at the most concentrated onsite evaporation pond. In addition, all input values and the model used to predict exposures at the proposed future evaporation ponds were reviewed and approved by the TWG.

The exposure assessment assumes that wildlife will drink from future onsite evaporation ponds. When surface water is potable, drinking water exposures generally account for less than

4 percent of the overall ingested dose (see Appendix VI.2). Predicted concentrations suggest that the salinity of surface water at the most concentrated onsite evaporation pond may be greater than seawater. It is anticipated that use of the onsite evaporation pond as a source of drinking water may be limited given the high salinity. The suitability of future onsite evaporation ponds as drinking water sources is another source of uncertainty. To reduce uncertainties associated with modeled concentrations and wildlife exposures, characterization and monitoring of future onsite evaporation ponds may be considered.

3.4.2 Uncertainties in the Effects Assessment

Sources of uncertainty related to COPC effects include:

- Use of chronic NOAEL-equivalent RTVs
- Species-to-species toxicity extrapolations
- Laboratory-to-field toxicity extrapolations
- Individual-to-population level effect extrapolations
- Constituent-to-constituent extrapolations
- Lack of relevant toxicity data for certain biota
- New toxicity values for certain biota
- Effects due to exposure to multiple COPCs

Use of Chronic NOAEL-Equivalent RTVs. The use of chronic NOAEL-equivalent RTVs is likely to result in conservative assessments of risk because environmental exposures were compared to toxicity levels at which no adverse effects were observed. Studies indicate that acute LD_{50}s derived from multiple dose toxicity tests show a high positive correlation with observed impacts in the environment (USEPA 1991c). DTSC (1996) considers NOAELs to be 100 times more sensitive than LD_{50}s and 10 times more sensitive than LOAELs. Thus, use of chronic NOAEL-equivalent RTVs provides a substantially greater level of protection than the use of the lowest doses at which effects are observed (LOAELs) or LD_{50}s.

Species-to-Species Toxicity Extrapolations. A source of uncertainty in the ERA is the lack of applicable species-specific toxicity data. Because of this data limitation, RTVs were developed using available toxicity data for laboratory test species. For example, RTVs for the desert kangaroo rat were developed from toxicity data for mice and rats. RTVs for indicator mammals and birds at mine and mill site AOCs were adjusted using allometric scaling factors provided by Sample and Arenal (1999). Allometric scaling is consistent with other efforts to develop RTVs for wildlife receptors that are derived from toxicity data for distinctly different test animals (Sample and Arenal 1999; Sample *et al*. 1996; Travis and White 1988, Travis *et al*. 1990).

Species vary with respect to sensitivity to specific chemicals (USEPA 1998b, Calabrese and Baldwin 1993, Venugopal and Luckey 1978). Based on our review of the toxicological data, the range of sensitivity for members within a class of vertebrates were typically up to 100-fold. This range of uncertainty is substantiated by Calabrese and Baldwin (1993). Although a range in sensitivity may be described, the relative sensitivity (and the "direction" of sensitivity) of desert wildlife species compared to laboratory test species to COPC exposures is not known.

Laboratory-to-Field Toxicity Extrapolations. A number of studies (primarily for aquatic systems) have evaluated the ability of single-chemical laboratory toxicity test results to predict adverse effects of that chemical on organisms under field conditions. Preliminary chemical contaminant studies suggest that laboratory toxicity tests represent more conservative exposure scenarios than those that occur in nature (USEPA 1991c). Furthermore, concentrations of chemicals causing no effect in laboratory tests also do not appear to affect communities in the field. Thus, the use of chronic NOAEL-equivalent RTVs are likely to provide a conservative level of protection to plant and wildlife communities and populations observed in the field.

Individual-to-Population Level Effect Extrapolations. The individual is the smallest biological "unit" that interacts directly with the environment (Suter 1992). Most toxicity data selected for the ERAs describe reproductive and developmental effects on individuals. Effects on individuals were then used to infer effects at the population level. Chronic reproductive impairment and abnormal development data were selected to facilitate inferences to population-level impacts (*e.g.*, abundance, extinction). Populations are typically more resistant to stress than individuals; the loss of a few sensitive individuals is not likely to significantly affect the population (Ricklefs 1990). In turn, communities are typically more resistant to stress than populations; the loss of a few populations is not likely to significantly affect the community (Ricklefs 1990). Therefore, inferences from toxic effects on individuals should provide a greater level of protection to populations and communities (Suter 1992).

Constituent-to-Constituent Extrapolations. Sufficient toxicity data to develop reference toxicity values for all constituents was not possible. To assess risks, constituent-to-constituent extrapolations were required. Use of constituent-to-constituent extrapolations is supported by the abundance of research work on QSARs (quantitative structure-activity relationships) reported in the pharmaceutical and medicinal chemistry literature that suggests that chemicals with similar molecular or physicochemical properties have similar biological reactivity and toxicity (Donkin 1994; Nirmalakhandan and Speece 1988). The use of constituent-to-constituent extrapolations is also consistent with guidance for human health risk assessment.

Toxicity extrapolations were also performed among lanthanides due to the limited toxicity data available for lanthanide metals, other than cerium and lanthanum. Existing toxicity data suggest that lanthanum is among the most toxic of lanthanide metals (Venugopal and Luckey 1978). Thus, a reference toxicity value derived from the toxicity of lanthanum is likely to provide a protective reference toxicity value for the other lanthanide metals.

Metals do not normally occur in the environment in an elemental form but, rather, as inorganic salts, ores, or in organic complexes. The form of the chemical strongly influences its bioavailability, and, thus, its toxicity. More soluble inorganic salts tend to be more bioavailable and, generally, more toxic than less soluble inorganic salt forms (ATSDR 1997). For the most part, RTVs were developed from studies where the more soluble salt forms were administered to test organisms. If less soluble forms exist in the environment, risks may be overestimated.

Much of the relevant toxicity literature for lead consists of studies where lead acetate is administered to test organisms. In fact, the mammalian RTVs for lead was based on a toxicity study where rats were administered lead acetate in drinking water (see Appendix D.5 of Appendix I). Based on available toxicity data, lead acetate appears to be significantly more toxic than other inorganic lead salts (Eisler 1988). For example, lead acetate is approximately 30 times more toxic to birds than metallic lead (see Appendix D.5 of Appendix I). Thus, the use of this RTV is likely to result in a significant overestimate of the risks to mammals.

Lack of Toxicity Data for the Desert Tortoise— The desert tortoise is a receptor of particular concern because it is a federally listed threatened species. The potential for adverse impacts to the desert tortoise due to the ingestion of metals, lanthanide metals, thorium, and uranium could not be directly evaluated due to the lack of an adequate database for relevant reptilian toxicity data.

While the pervasive approach in ERAs is the protection of the population, this perspective was modified to assess risk to a species protected by law under the Endangered Species Act (ESA). No specific guidance exists on uncertainty factors for threatened and endangered species. Calabrese and Baldwin (1993) state that "it is highly uncertain what type of variation to expect for endangered species… and there is no obvious means to determine how to derive such a [uncertainty] value." While no specific guidance exists on uncertainty factors for endangered/threatened species, this extrapolation bears considerable resemblance to the human health assessment extrapolation where the objective is to protect susceptible subgroups within the population.

The lack of an adequate database, sensitivity to ESA issues, and particular interest in conducting a protective evaluation of risk for the desert tortoise were key motivating factors for applying an additional uncertainty factor (or safety factor) for the desert tortoise. To ensure a conservative assessment of the desert tortoise, avian RTVs were divided by a 20-fold uncertainty factor to account for the bird-to-reptile extrapolation and an added level of protection for this threatened species (see Section T5.8.2 of Appendix I). Application of a 20-fold uncertainty factor was based on best professional judgment, is consistent with the approach for evaluating risk to susceptible subgroups within human populations, and is consistent with suggestions provided by Calabrese and Baldwin (1993) in *Performing Ecological Risk Assessments.*

It should be noted that unusually high metal concentrations have been detected in apparently healthy reptiles from seemingly intact populations in affected habitats (Linder and Grillitsch in press). In their review, Linder and Grillitsch (in press) suggest that metal resistant populations have evolved among reptiles. However, given the current limited amount of metal toxicity data for reptiles, it cannot be accurately ascertained to what degree use of avian toxicity data that have been modified by a 20-fold uncertainty factor may over- or underestimate potential risks to the desert tortoise.

Lack of Toxicity Data for Lanthanide Metals— The lack of lanthanide toxicity data for plants, sediment-associated invertebrates, and birds severely hampers assessments of risk for these receptors. However, for plants, existing bioaccumulation studies indicate that plants do not absorb the lanthanides from soils due to discrimination against their absorption by the roots (Venugopal and Luckey 1978). These data suggest that plants may be less susceptible to lanthanide toxicity compared to other receptors. Plant bioassays may be considered to reduce uncertainties associated with the lack of plant toxicity data.

Because lanthanide metals are of particular interest, the TWG allowed a qualitative comparison to risk estimates for mammals as a point-of-reference. Concentrations of lanthanide metals at the Lanthanide Storage (and, to a lesser degree, at the Windblown Tailings, Seepage Collection Pond, future Pit Lake, and East Tailings Pond) pose a risk to the desert kangaroo rat and desert shrew. If birds or the desert tortoise are as sensitive to lanthanide metals as small mammals[12], a similar pattern in potential risk would be observed.

ERAs were limited due to the lack of relevant toxicity values for several metals:

- *Sediment-Associated Invertebrates*—barium, beryllium, cobalt, manganese, molybdenum, selenium, thallium, and vanadium.
- *Soil Invertebrates*—antimony, beryllium, manganese, selenium, silver, thallium, and vanadium.
- *Birds*—antimony, beryllium, cobalt, silver, and thallium.

Some metals (in particular, barium) for which limited toxicity information exists are expected to be associated with releases from the mine and mill site. However, the absence of RTVs for most of these metals may not be critical data gaps since most of these metals are not typically associated with releases from the mine and mill site (ENSR 1996).

New Toxicity Values for Certain Biota. RTVs were reviewed by TWG members and were

[12] This comparison is for perspective only—insufficient toxicity data exist to determine (even in a qualitative sense) the relative sensitivity to lanthanide metals.

established for use in this screening-level ERA in late 1999-early 2000. New numeric water quality criteria for priority toxic pollutants in waters in the State of California are now being promulgated by the U.S. Environmental Protection Agency under the new California Toxics Rule (Federal Register 2000). Similarly, MacDonald *et al.* (2000) has provided new sediment quality guidelines for freshwater ecosystems. These new values were not used in this ERA because agreements had already been established and re-establishment of RTVs would have had cost and scheduling impacts on the HHERA effort.

A cursory review of water quality criteria provided in the new California Toxics Rule and sediment quality guidelines proposed by MacDonald *et al.* (2000) suggests that these values differ only slightly from the RTVs used in this ERA (Table 3-29a,b). Furthermore, chemical-specific coefficients proposed in the California Toxics Rule to develop hardness-dependent water quality criteria are very similar to chemical-specific coefficients used to develop hardness-specific RTVs for aquatic biota in this ERA (with the exception of chromium). The California Toxics Rule's hardness-dependent water quality criteria for chromium appears to be less conservative than the hardness-dependent National Ambient Water Quality Criteria used in this screening level ERA.

For the most part, the use of new values is likely to have a negligible affect on the overall conclusions of this ERA. However, incorporation of new values may be considered in the EIR.

Effects Due to Exposure to Multiple COPCs. Effects due to exposure to multiple radionuclides are not accounted for in this screening-level ERA. Metals are known to have synergistic, antagonistic, or neutral influence on the toxicity of other metals (Calabrese 1991). However, there is a lack of data required to describe the degree to which toxicity may be affected due to exposures to multiple COPCs present at mine and mill site AOCs.

It should be noted that the summed HQs in risk summary tables were provided only to facilitate spatial comparisons—summed HQ values are not intended to demonstrate the total risk due to exposure to multiple COPCs.

3.4.3 Overall Uncertainty in Risk Characterization

The largest sources of uncertainty are (a) the bioaccumulation of COPCs in food and (b) toxicity reference values (and/or lack thereof) (Figure 3-13). In general, the types, magnitude, and direction of relative uncertainties for the Molycorp mine and mill site ERA are comparable to uncertainties for predictive ERAs at other sites where only media concentrations are available (*i.e.,* no available tissue burden or bioassay data). However, the consequences of uncertainties may be more pronounced because desert systems are slow to recover (Rundel and Gibson 1996).

The primary literature contains a limited number of field studies conducted to validate the findings of predictive risk assessments. These studies suggest that (a) exposures in laboratory toxicity tests are likely to overestimate exposures in the field resulting in overestimates of risk (USEPA 1991c) and (b) plants regulate internal tissue levels for metals (Alsop *et al.* 1996). Both of these findings tend to suggest that risks may be overestimated using HQs.

Given onsite visual observations, lessons learned from validation studies, and experience at other sites, confidence (in the assessment) is relatively high that a potential for risks exists at AOCs with relative risks are greater than 10. In addition, confidence is relatively high when comparing relative risks among AOCs since the same uncertainties act (and, thus nullifying each other) across all AOCs. Confidence is lower when comparing relative risks between baseline and future expansion scenarios because much of the future exposures are based on surrogate data (*e.g.,* Pit Lake) or modeled data (*e.g.,* future onsite evaporation ponds).

It should be noted that desert ecosystems require a long period of time (on the order of decades) to recover. To reduce uncertainties, focused verification of the ERAs may be considered. Carefully monitored control measures and focused controls to reduce contact are likely to significantly reduce the potential for current or future adverse ecological impacts at mine and mill site AOCs. Judicious monitoring at future expansion scenario AOCs can provide the information needed to minimize future risks.

3.5 SUMMARY

Potential ecological risks were evaluated for the following biological resources observed at the mine and mill site:

- Aquatic and sediment-associated invertebrate communities
- Plant communities
- Soil invertebrate communities
- Desert tortoise and other reptile populations
- Waterfowl populations
- Herbivorous, insectivorous, and carnivorous bird populations
- Herbivorous, insectivorous, and carnivorous mammal populations

Fish and amphibians have not been observed at the mine and mill site AOCs and were not evaluated due to the lack of suitable habitat.

Ecological risks were evaluated for twelve onsite AOCs and one potentially affected offsite AOC. To ensure a protective ERA, risks were assessed even though most of the AOCs are located in areas that were developed for industrial use, are highly disturbed, are characterized by human and/or vehicular activity, and may be considered less attractive to wildlife compared to nearby, less-disturbed desert habitats.

3.5.1 Potential for Adverse Ecological Impacts Under the Baseline Scenario

Under the baseline scenario, all mine and mill site AOCs (except the North Tailings Pond) pose some potential risk to terrestrial plant, invertebrate, and wildlife receptors. For most constituent exposures, risks are relatively low (*i.e.*, HQs less than 5 or less than 5 times background).

The greatest potential for adverse impacts exists for:

- Aquatic and sediment-associated invertebrate communities at onsite springs in drainages downgradient from the North Tailings Pond
- Desert plant communities at the Seepage Collection Pond, Windblown Tailings, and Overburden Stockpile
- Soil invertebrate communities at the Lanthanide Storage Ponds
- Mammal populations at the Lanthanide Storage Pond

A single desert tortoise, a federally threatened species, has been observed outside the western boundary of the site. Although no desert tortoises have been observed in areas examined in this ERA, risks to the desert tortoise were evaluated to ensure a conservative assessment. Risk estimates for the desert tortoise were among the lowest calculated for the mine and mill site; however, exposures at the Lanthanide Storage Ponds and Overburden Stockpile posed the greatest risk to this species of regulatory concern.

Constituents of Concern. Exposures to strontium and uranium posed the greatest risk to aquatic invertebrates; whereas, exposures to lead posed the most widespread (and frequently the greatest) risk to terrestrial plant, invertebrate, and wildlife receptors. In addition to lead, the following COPCs posed a risk to ecological receptors:

- Lanthanide metals: soil invertebrate communities, mammal populations;
- Antimony, barium, and molybdenum: mammalian wildlife populations
- Radionclides: soil invertebrate communities, waterfowl populations, and insectivorous wildlife populations

Conversely, exposures to uranium pose a negligible risk to most ecological receptors (with the exception of aquatic invertebrate and plant communities).

Spatial Patterns. Risk summary maps show potential risks to (a) aquatic receptors, (b) plants and herbivorous receptors, and (c) soil invertebrates and insectivorous receptors (Figures 3-14a-c). Color-coded total relative risks[13] are shown in Figures 3-14a-c only to facilitate spatial comparisons—summed HQ values are not intended to demonstrate or suggest the magnitude of total risk due to exposures to multiple COPCs[14].

AOCs were categorized according to risk to terrestrial receptors of concern:

Greatest Potential for Risk

- Seepage Collection Pond
- Lanthanide Storage Ponds
- Windblown Tailings
- Overburden Stockpile

Intermediate Potential for Risk

- 17 Spring[15]
- Jack Meyer's Pond Spring[16]
- Sewage Treatment Pond
- Administration Pond

Negligible Potential for Risk

- North Tailings Pond
- Wheaton Wash/Roseberry Spring

Risks tend to diminish with distance from AOCs posing the greatest risk to receptors of concern.

Risk estimates for the Wheaton Wash/Roseberry Spring suggest that nearby offsite habitats are likely to be minimally impacted by mine-related activities since exposures to constituents pose a negligible risk to terrestrial receptors.

No vegetation was observed in the Lanthanide Storage Ponds during the recent field survey (Tetra Tech 2000a). Sparse ruderal vegetation was observed at the Overburden Stockpile. Stressed vegetation was observed at the Windblown Tailings, in the North Tailings Pond, and at the Seepage Collection Ponds. No overt signs of stressed vegetation were observed at reference background locations, at offsite springs (*i.e.*, Wheaton Wash/Rosberry Spring), and in undisturbed areas further than 100 feet from developed water impoundments. It should be noted that the cause of stressed vegetation at the Overburden Stockpile, at the Windblown Tailings, and around the developed water impoundments may have little to do with COPC concentrations in soils since these areas are subject to a high degree of physical disturbance (*e.g.*, road traffic, burial by tailings). Nonetheless, visual observations appear to coincide with relative risks greater than 10.

Risks at the Overburden Stockpile and onsite water impoundments may be confined to the AOC (and the area immediately surrounding the AOCs). Based on site visits, areas as little as 100 feet from mine and mill site AOCs provide attractive desert scrub habitat. Moreover, risk estimates for the North Tailings Pond suggest that nearby habitats are likely to pose a minimal risk to desert receptors.

Minimally disturbed desert scrub habitat was often observed within 100 feet of these AOCs. Nonetheless, findings of negligible risk for the area surrounding the North Tailings Pond (without the windblown tailings) suggest that carefully monitored control measures at developed impoundments and focused controls to reduce contact are likely to significantly reduce the potential for adverse ecological impacts at mine and mill site AOCs.

[13] Sum of HQs for metals, lanthanide metals, uranium, and radionuclides.

[14] Several detected metals are known to have an antagonistic influence on the toxicity of other metals. An arbitrary assumption of additive effects across all COPCs without regard to mechanisms of action and common target organs is not supported by the existing physicochemical and pharmacokinetic literature (Donkin 1994; Nirmalakhandan and Speece 1988).

[15] Representative of springs in Farmer's Wash, downgradient from the North Tailings Pond.

[16] Representative of springs between P-16 and Mexican Well.

3.5.2 Potential for Adverse Ecological Impacts Under the Future Expansion Scenario

Under the future scenario, all mine and mill site AOCs (except the Future Onsite Evaporation Pond) pose some potential risk to terrestrial plant, invertebrate, and wildlife receptors. For most constituent exposures, risks are relatively low (*i.e.*, HQs less than 5 or less than 5 times background). Because baseline scenario conditions were used to estimate future risks, ecological risks under the future expansion scenario are similar to the baseline scenario with the following exceptions:

- Closure and reclamation of North Tailings Pond
- Construction of a lined East Tailings Pond to handle future tailings processing
- Loss of several onsite springs due to elimination of seepage from Tailings Pond
- Construction of onsite evaporation ponds
- Formation of Pit Lake at the open pit mine

Unless future reclamation efforts are performed, exposures at the Seepage Collection Pond, Lanthanide Storage Ponds, and Overburden Stockpile will pose potential future risks to desert plant communities, invertebrate communities, and/or wildlife populations.

Based on the findings of this screening-level ERA, the greatest potential future risks are to (a) sediment-associated invertebrates at the future Pit Lake and (b) plant communities (and, to a lesser degree, soil invertebrate communities, and insectivorous mammal populations) at the future Pit Lake and East Tailings Pond.

Constituents of Concern. Similar to the baseline scenario, exposures to lead posed the most widespread (and frequently the greatest) risk to terrestrial plant, invertebrate, and wildlife receptors. In addition to lanthanide metals and lead, the following COPCs posed a risk to ecological receptors:

- Lanthanide metals: soil invertebrate communities, mammal populations;
- Antimony, barium, and molybdenum: mammalian wildlife populations
- Radionclides: soil invertebrate communities, waterfowl populations, and insectivorous wildlife populations

Conversely, exposures to uranium pose a negligible risk to most ecological receptors (with the exception of aquatic invertebrate and plant communities).

Spatial Patterns. Under the proposed plan, the North Tailings Pond will be closed and reclaimed. A lined East Tailings Pond will be established to handle future tailings processing. Thus, seepage of tailings pond water is expected to be eliminated. The elimination of tailings pond seepage will (a) result in the loss of several attractive onsite springs (*e.g.*, Jack Meyer's Pond Spring, 17 Spring) and (b) significantly reduce metal, lanthanide metal, and radionuclide exposures to aquatic and sediment-associated invertebrate communities in nearby, offsite springs (*e.g.*, Roseberry Spring). However, if seepage is not eliminated, the HQs suggest that aquatic and sediment-associated invertebrates in downgradient springs may be adversely impacted. In addition, ERAs indicate that the windblown tailings at the East Tailings Pond will pose a potential risk to desert plants, soil invertebrates, and wildlife, unless control measures are effectively applied to prevent the offsite transport of tailings.

The future groundwater-fed Pit Lake is expected to offer attractive habitat for ecological receptors. Exposures at the future Pit Lake are predicted to pose a risk to plants, sediment-associated invertebrates, soil invertebrates, waterfowl, and insectivorous mammals. These exposures were estimated using constituent concentrations in nearby soils (*i.e.*, haul road soils) and in groundwater at nearby, upgradient monitoring wells. The Phase 3 Reclamation Plan should address future exposures at the Pit Lake.

Proposed future onsite evaporation ponds will cover approximately 130 acres in the northwestern portion of the mine and mill site and will be surrounded by a chain-link fence to restrict access by large wildlife, including the desert tortoise. These lined, steep-sided ponds are expected to hold water throughout the year, limiting contact with and substantially reducing windblown transport of pond solids. Predicted exposures at the proposed future onsite evaporation ponds were based on modeled concentrations. Conservative assumptions were used to ensure a protective evaluation of potential risk and include:

- No treatment of the wastestream prior to discharge to onsite ponds
- Wildlife are exposed to concentrations equivalent to those at the most concentrated pond
- Wildlife are exposed to both surface water and solids

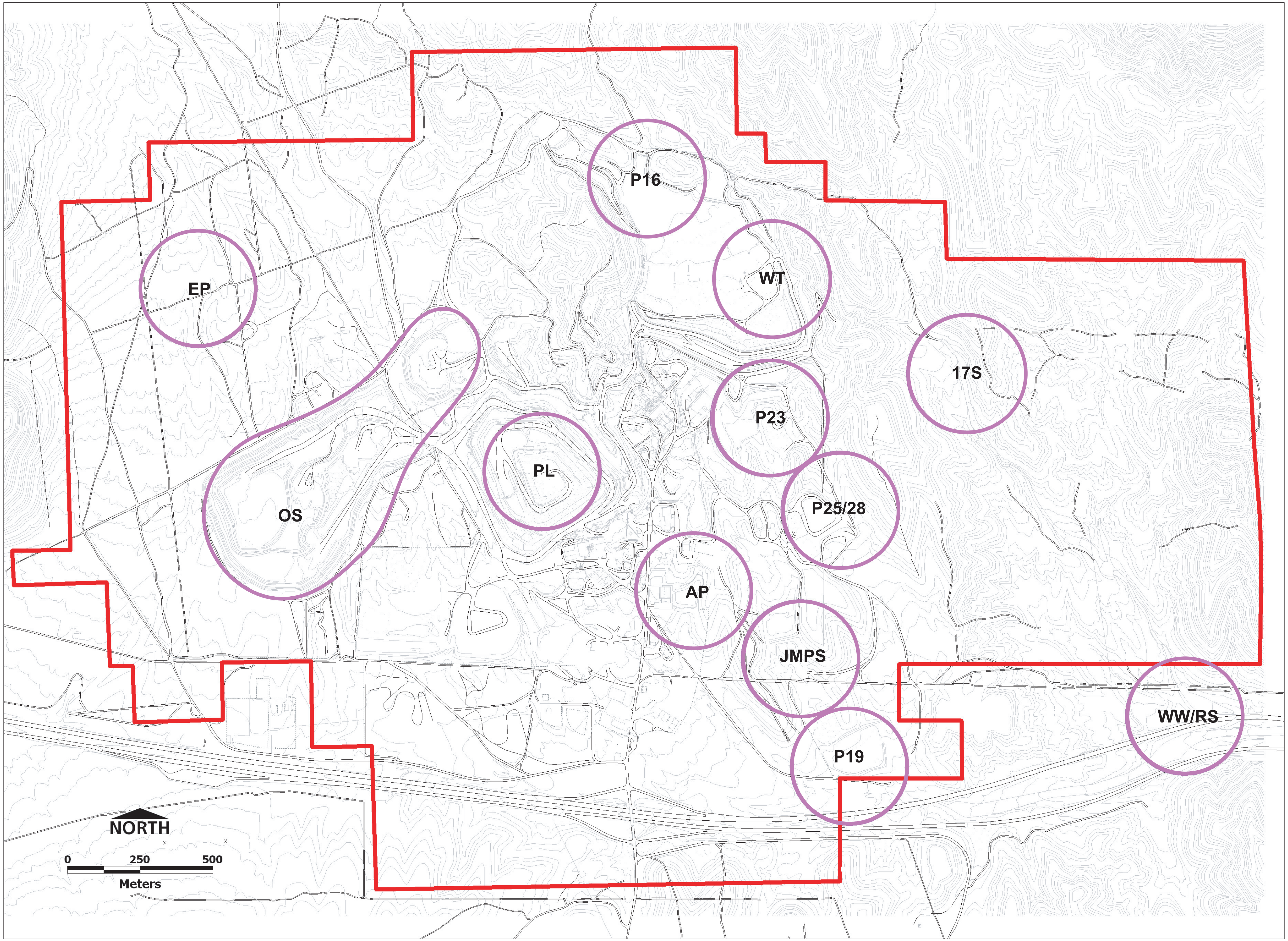
Exposures to lanthanide metals, uranium, and radionuclides at the future onsite evaporation ponds pose a negligible potential for adverse impacts to ecological receptors. Only exposures to strontium and thallium for herbivorous and insectivorous mammals) and zinc (for insectivorous birds) pose a potential for ecological risks.

Of additional interest may be the Overburden Stockpile. Although substantial changes in concentrations of constituents may not occur, this AOC is projected to increase from an existing 88 acres to 305 acres under the proposed plan. Again, it should be emphasized that when in use, the Overburden Stockpile provides little or no attractive habitat for ecological receptors. However, the Phase 3 Reclamation Plan should address potential exposures to material that has been brought to the surface.

Preliminary analyses for mammals indicate that restricting access to the Lanthanide Storage Ponds and Tailings Pond (both current and future) would significantly reduce wildlife exposure to lanthanide metals at the mine and mill site. Given the lack of lanthanide toxicity data for many biological resources, restricting access may be considered in the EIR as an initial cost-effective means to minimize potential risks.

In addition to verifying risk calculations, judicious monitoring at future expansion scenario AOCs can provide information needed to proactively minimize or eliminate potential future risks.

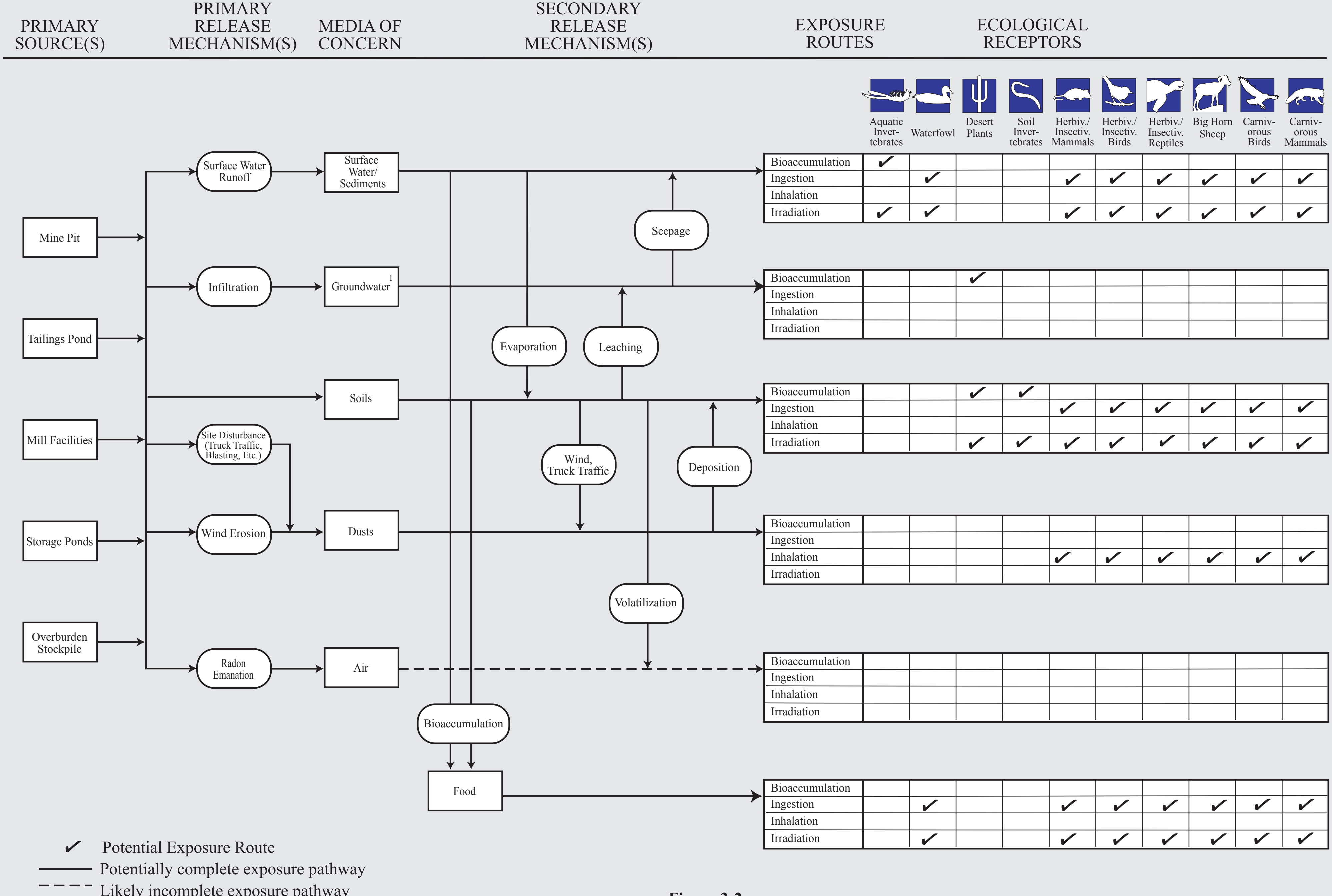
Figure 3-1
Areas of Concern for the Ecological Risk Assessment at Molycorp Mountain Pass Mine



Circles delineate ecological AOCs (13 ha)

Circles are drawn to scale

OS	Overburden Stockpile
WT	Windblown Tailings
P16	North Tailings Pond
P23	Seepage Collection Pond
P25/28	Lanthanide Storage Pond
P19	Sewage Treatment Pond
AP	Administration Pond
JMPS	Jack Meyer's Pond Spring
17S	17 Spring
WW	Wheaton Wash
RS	Roseberry Spring
PL	Pit Lake (Future)
EP	Future Onsite Evaporation Pond



Surface Water/Sediments:

Exposure Route	Aquatic Invertebrates	Waterfowl	Desert Plants	Soil Invertebrates	Herbiv./Insectiv. Mammals	Herbiv./Insectiv. Birds	Herbiv./Insectiv. Reptiles	Big Horn Sheep	Carnivorous Birds	Carnivorous Mammals
Bioaccumulation	✓									
Ingestion		✓			✓	✓	✓	✓	✓	✓
Inhalation										
Irradiation	✓	✓			✓	✓	✓	✓	✓	✓

Groundwater:

Exposure Route	Aquatic Invertebrates	Waterfowl	Desert Plants	Soil Invertebrates	Herbiv./Insectiv. Mammals	Herbiv./Insectiv. Birds	Herbiv./Insectiv. Reptiles	Big Horn Sheep	Carnivorous Birds	Carnivorous Mammals
Bioaccumulation			✓							
Ingestion										
Inhalation										
Irradiation										

Soils:

Exposure Route	Aquatic Invertebrates	Waterfowl	Desert Plants	Soil Invertebrates	Herbiv./Insectiv. Mammals	Herbiv./Insectiv. Birds	Herbiv./Insectiv. Reptiles	Big Horn Sheep	Carnivorous Birds	Carnivorous Mammals
Bioaccumulation			✓	✓						
Ingestion					✓	✓	✓	✓	✓	✓
Inhalation										
Irradiation			✓	✓	✓	✓	✓	✓	✓	✓

Dusts:

Exposure Route	Aquatic Invertebrates	Waterfowl	Desert Plants	Soil Invertebrates	Herbiv./Insectiv. Mammals	Herbiv./Insectiv. Birds	Herbiv./Insectiv. Reptiles	Big Horn Sheep	Carnivorous Birds	Carnivorous Mammals
Bioaccumulation										
Ingestion										
Inhalation					✓	✓	✓	✓	✓	✓
Irradiation										

Air:

Exposure Route	Aquatic Invertebrates	Waterfowl	Desert Plants	Soil Invertebrates	Herbiv./Insectiv. Mammals	Herbiv./Insectiv. Birds	Herbiv./Insectiv. Reptiles	Big Horn Sheep	Carnivorous Birds	Carnivorous Mammals
Bioaccumulation										
Ingestion										
Inhalation										
Irradiation										

Food:

Exposure Route	Aquatic Invertebrates	Waterfowl	Desert Plants	Soil Invertebrates	Herbiv./Insectiv. Mammals	Herbiv./Insectiv. Birds	Herbiv./Insectiv. Reptiles	Big Horn Sheep	Carnivorous Birds	Carnivorous Mammals
Bioaccumulation										
Ingestion		✓			✓	✓	✓	✓	✓	✓
Inhalation										
Irradiation		✓			✓	✓	✓	✓	✓	✓

1 Shallow Groundwater Only (< 20 ft bgs)

Figure 3-2

Mountain Pass Mine and Mill Site Conceptual Site Model for Ecological Receptors.

Figure 3-3. Jack Meyer's Pond Spring

Figure 3-4. 17 Spring

Figure 3-5. Background Location (Older Alluvium).

Figure 3-6. Wheaton Wash.

Figure 3-7. North Tailings Pond (P-16).

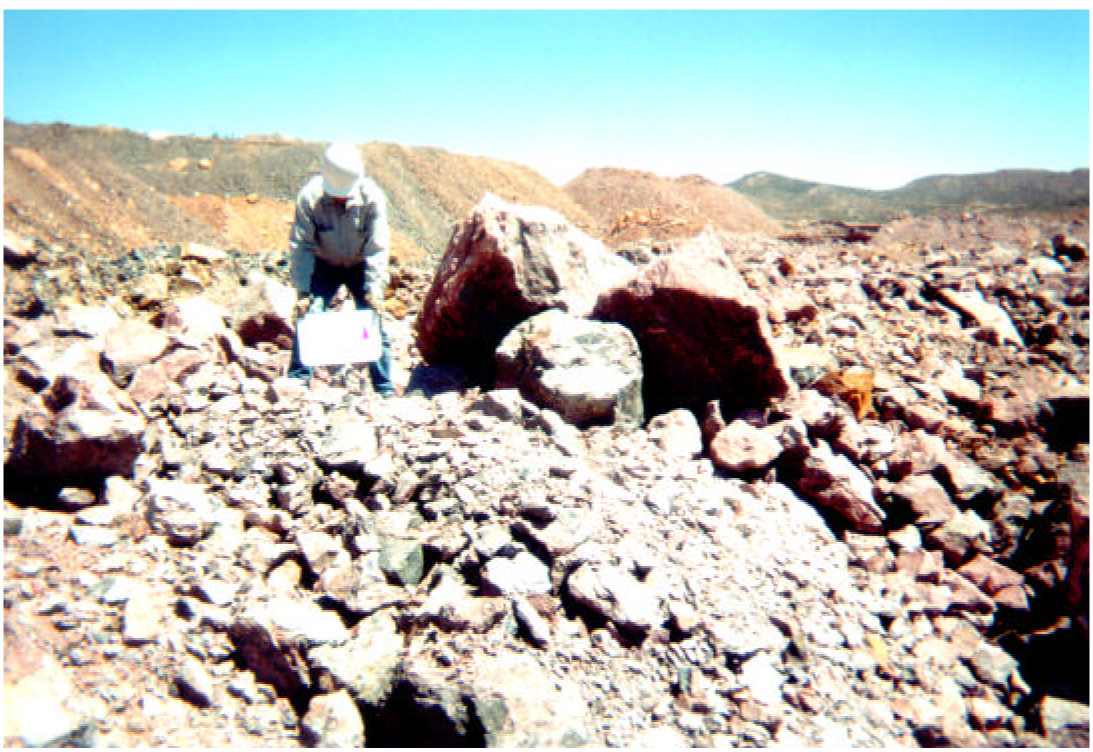


Figure 3-8. Overburden Stockpile

Figure 3-9. Windblown Tailings.

Figure 3-10. Haul Roads and Open Pit Mine.

Figure 3-11. Seepage Collection Pond (P-23a).

Figure 3-12. Lanthanide Storage Pond (P-25b)

Figure 3-13.
Qualitative Summary of Relative Uncertainty in Ecological Risk Assessments for the Mine and Mill Site

Sources of Uncertainty	Predominant Type of Uncertainty
Exposure Assessment	
Use of indicator species	Variability
Site presence index	Unknown true value
Bioaccumulation factors	Unknown true value
Omission of dermal contact	Data gap
Surrogate exposure data	Data gap
Future exposures	Data gap
Effects Assessment	
Use of chronic NOAEL-equivalent RTVs	Unknown true value
Species-to-species toxicity extrapolations	Variability
Laboratory-to-field toxicity extrapolations	Unknown true value
Individual-to-population level effect extrapolations	Unknown true value
Consituent-to-constituent extrapolations	Unknown true value
Lack of relevant toxicity data for certain biota	Data gap
New toxicity values for certain biota	Variability
Effects due to exposure to multiple COPCs	Data gap

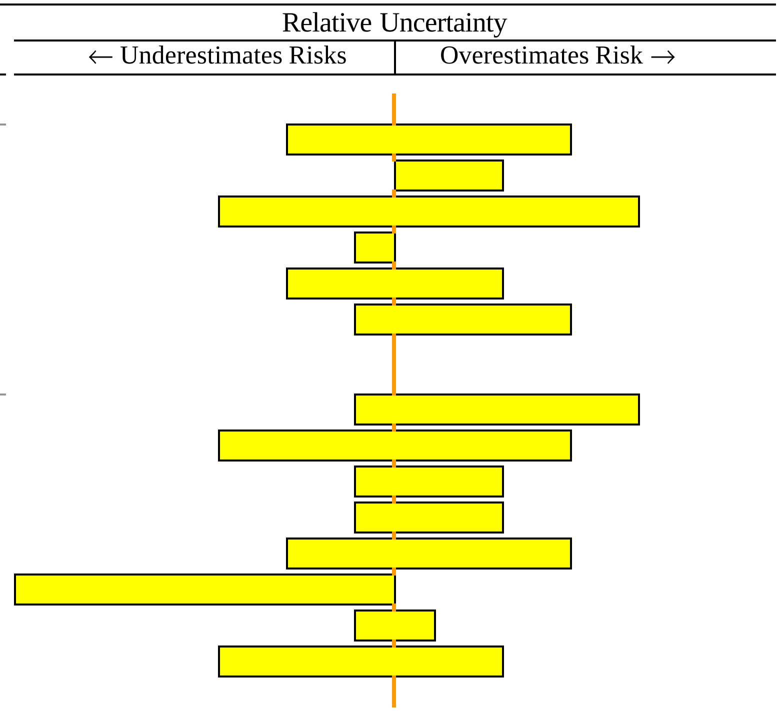
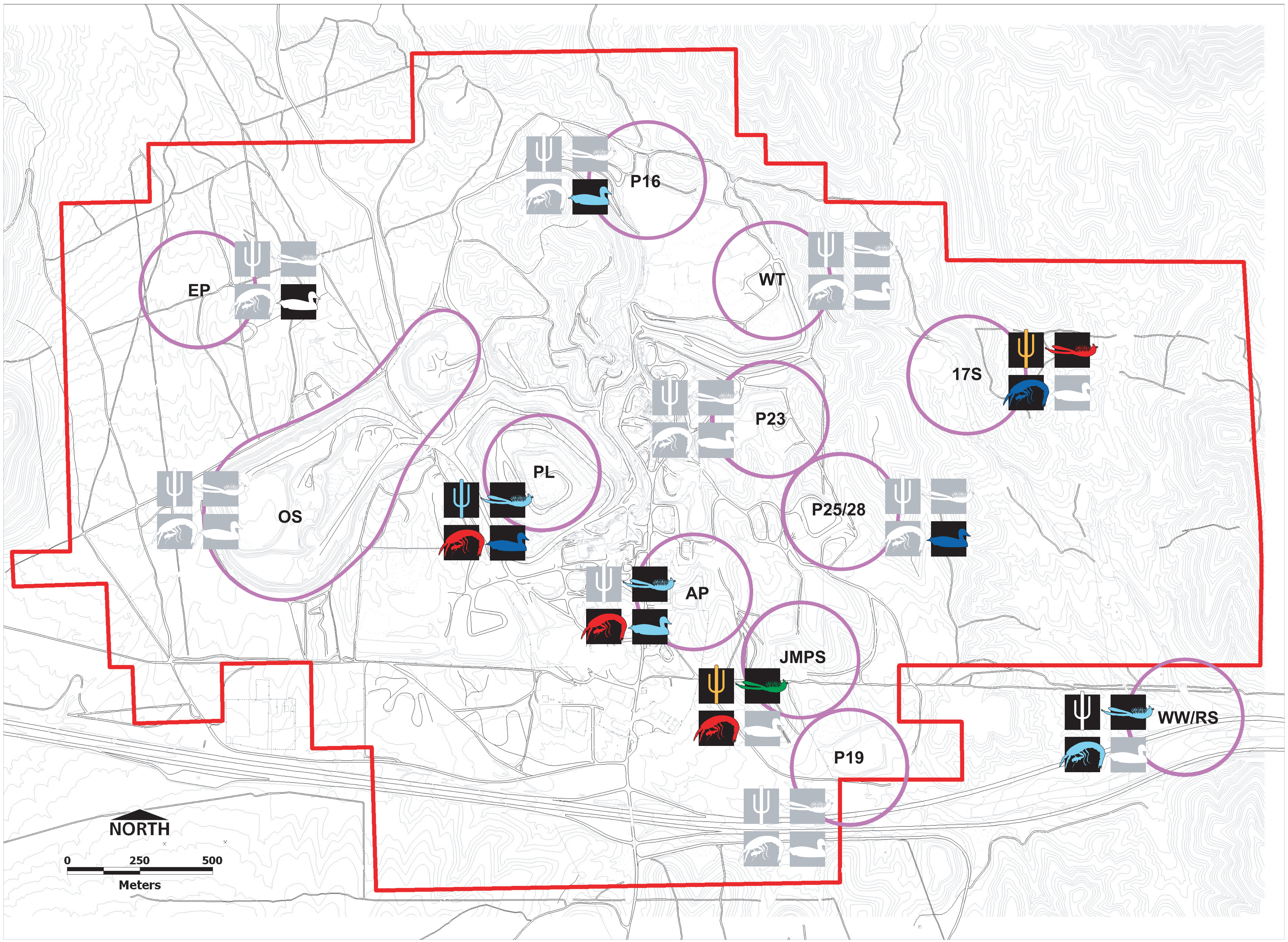


Figure 3-14a
Summary of Relative Risks at Molycorp Mountain Pass Mine: Aquatic Ecological Receptors



Circles delineate ecological AOCs (13 ha)

Circles are drawn to scale

OS	Overburden Stockpile
WT	Windblown Tailings
P16	North Tailings Pond
P23	Seepage Collection Pond
P25/28	Lanthanide Storage Pond
P19	Sewage Treatment Pond
AP	Administration Pond
JMPS	Jack Meyer's Pond Spring
17S	17 Spring
WW	Wheaton Wash
RS	Roseberry Spring
PL	Pit Lake (Future)
EP	Future Onsite Evaporation Pond

Desert Plant Community *(Roots Contacting Shallow Groundwater)*

Aquatic Invertebrate Community *(Fairy Shrimp)*

Sediment-Associated Invertebrate Community *(Amphipod)*

Water Foul *(Northern Shoveler)*

Relative risks are based on summed HQs. Summed HQs are provided only to facilitate spatial comparisons - summed HQ values are not intended to demonstrate the magnitude of total risk. Relative risks are calculated according to the decision tree provided in Section 3.3, *Hazard Quotients.*

>25

21-25

16-20

11-15

6-10

1-5

<1

Insufficient data

Receptor not present at AOC

\\f_HHERA Rpt_3_ERA\Figure 3-14a.ai

Figure 3-14b
Summary of Relative Risks at Molycorp Mountain Pass Mine: Plants and Herbivorous Ecological Receptors

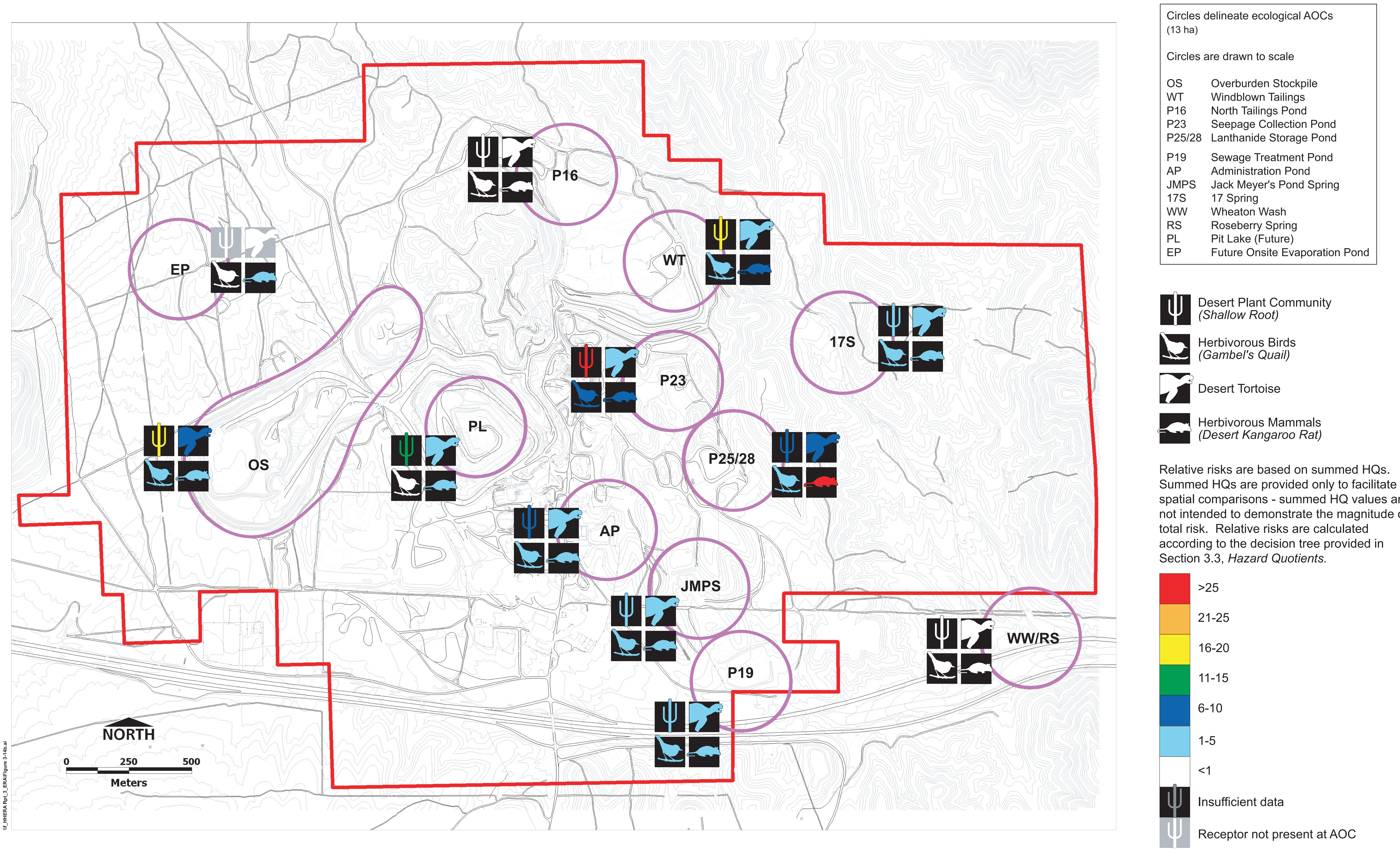
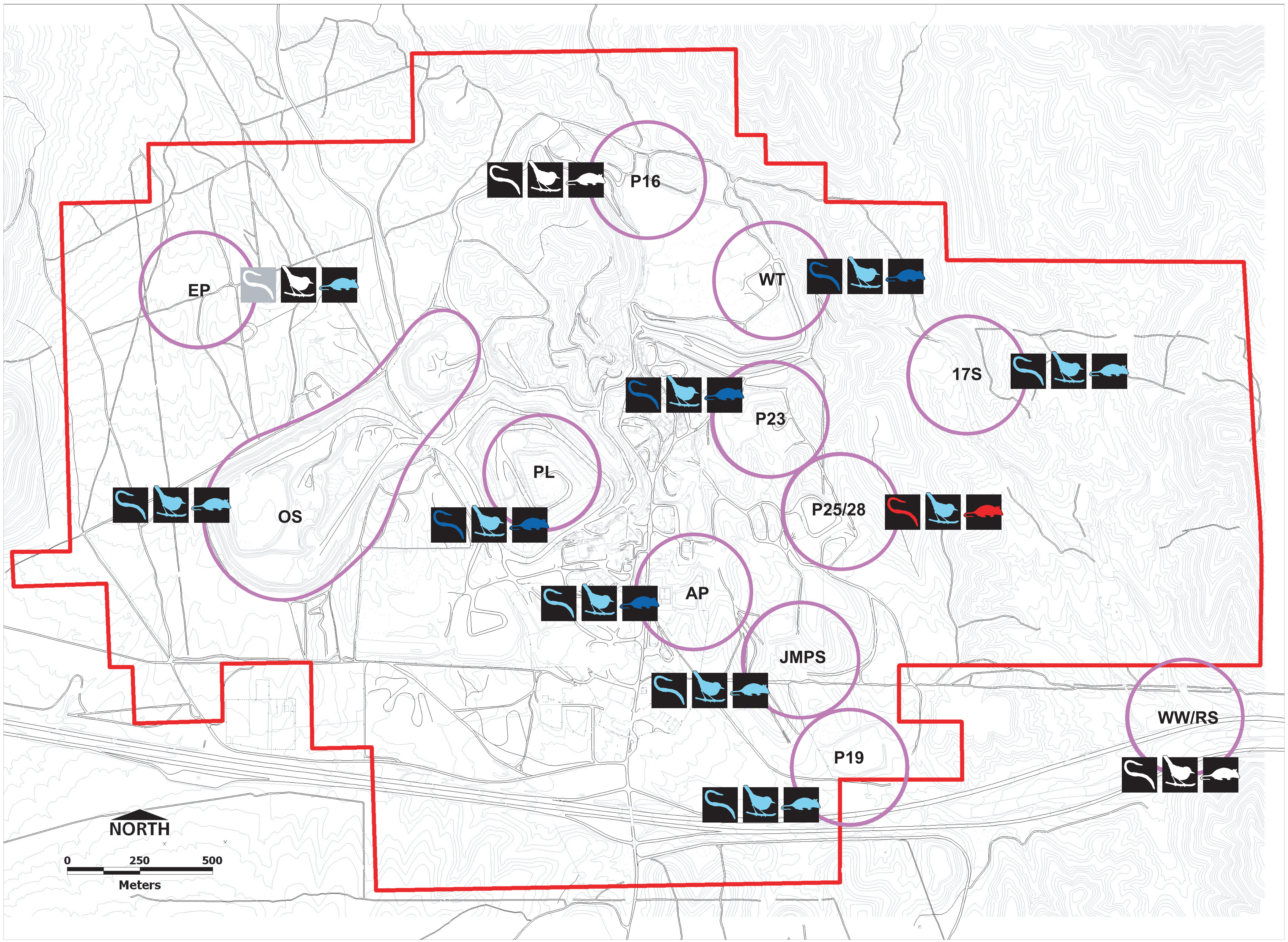


Figure 3-14c
Summary of Relative Risks at Molycorp Mountain Pass Mine: Soil Invertebrates and Insectivorous Ecological Receptors



Circles delineate ecological AOCs (13 ha)

Circles are drawn to scale

OS	Overburden Stockpile
WT	Windblown Tailings
P16	North Tailings Pond
P23	Seepage Collection Pond
P25/28	Lanthanide Storage Pond
P19	Sewage Treatment Pond
AP	Administration Pond
JMPS	Jack Meyer's Pond Spring
17S	17 Spring
WW	Wheaton Wash
RS	Roseberry Spring
PL	Pit Lake (Future)
EP	Future Onsite Evaporation Pond

Soil Invertebrate *(Earthworm)*

Insectivorous Birds *(Cactus Wren)*

Insectivorous Mammals *(Desert Shrew)*

Relative risks are based on summed HQs. Summed HQs are provided only to facilitate spatial comparisons - summed HQ values are not intended to demonstrate the magnitude of total risk. Relative risks are calculated according to the decision tree provided in Section 3.3, *Hazard Quotients.*

>25

21-25

16-20

11-15

6-10

1-5

<1

Insufficient data

Receptor not present at AOC

Table 3-1
Ecological Risk Assessment Areas of Concern at Mountain Pass Mine & Mill Site

ERA Areas of Concern	ERAs: Baseline	ERAs: Future Expansion	ERAs: Reference	AOC Area (ha)
Industrial Areas				
• Open pit mine	- NA -	1	- NR -	13
• Haul roads	- NA -	- NA -	- NR -	- NR -
• Warehouse	- NA -	- NA -	- NR -	- NR -
• Overburden stockpile	·	3	- NR -	36, 123[c]
Developed Water Impoundments				
• North Tailings Pond (P-16)	·	2	- NR -	13
• Windblown Tailings	·	2	- NR -	13
• Seepage Collection Ponds (P-23)	·	3	- NR -	13
• Lanthanide Storage Ponds (P-25b, P-28)	·	3	- NR -	13
• Sewage Treatment Pond (P-19)	·	3	- NR -	13
• Administration Pond	·	3	- NR -	13
Intermittent Springs				
• 17 Spring[a]	·	- NA -	- NR -	13
• Jack Meyer's Pond Spring[b]	·	- NA -	- NR -	13
• Wheaton Wash/Roseberry Spring	·	3	- NR -	13
Proposed Future Facilities				
• Pit lake	- NR -	·	- NR -	13
• East Tailings Pond/Windblown Tailings	- NR -	·	- NR -	13
• Onsite Evaporation Ponds	- NR -	·	- NR -	13
Reference Areas				
• Carbonitite	- NR -	- NR -	·	13
• Shonkenite	- NR -	- NR -	·	13
• Bedrock	- NR -	- NR -	·	13
• Older alluvium	- NR -	- NR -	·	13
• Younger alluvium	- NR -	- NR -	·	13
• Mixed soil	- NR -	- NR -	·	13
• Garden Spring	- NR -	- NR -	·	13

Notes:

· Was assessed

1 = see Future Expansion, Pit Lake

2 = see Future Expansion, East Tailings Pond

3 = Same as baseline scenario

a = Representative of springs in Farmer's Wash

b = Representative of springs between P-16 and Mexican Well

c = 36 ha for baseline scenario; 123 ha for future scenario

ERA = Ecological risk assessment

NA = Not assessed

NR = Not relevant

Table 3-2
Background Soil Types Used to Identify Constituents of Potential Concern and to Characterize Reference Exposures.

ERA Areas of Concern	Background Soil Types Found at or Near AOC[1]	Background Soil Type Used to Identify COPCs[2]	Background Soil Types Used to Characterize Reference Exposures[3]
Industrial Areas			
• Overburden stockpile	YA, BD, OA	YA	YA, BD, OA
Developed Water Impoundments			
• N.Tailings Pond [P-16]	BD, SK	BD	BD, SK
• Windblown tailings	BD, OA	OA	BD, OA
• Seepage Collection Pond [P-23a]	BD	BD	BD
• La Storage Pond [P-25b,28]	OA, BD	OA	OA, BD
• Sewage Treatment Pond [P-19]	MX, OA, BD	MX	MX, OA, BD
• Administration Pond	OA	OA	OA
Intermittent Springs			
• 17 Spring	OA, BD	OA	OA, BD
• Jack Meyer's Pond Spring	OA	OA	OA
• Wheaton Wash/Roseberry Spring	OA, MX, BD	MX	OA, MX
Proposed Future Expansions			
• Pit Lake	BD, SK	BD	BD, SK
• East Tailings Pond/Windblown Tailings	— see N.Tailings Pond/Windblown Tailings —		
• Onsite Evaporation Ponds	BD, YA	-[4]	BD, YA

Notes:

1 = Based on geologic map, Figure 3-1 in the Sampling Work Plan (Tetra Tech 1999).
2 = Background data were selected because they provide protective and defensible screening values relative to other possible COPC screening values.
3 = Data used to calculate risks due to exposures at reference background locations.
4 = Comparison to background soil was not possible for identification of COPCs because only mean concentrations were available. All constituents analyzed at the onsite evaporation ponds were selected as COPCs.

BD = Bedrock
CB = Carbonitite
MX = Mixed
OA = Older alluvium
SK = Shonkenite
YA = Younger alluvium

Table 3-3
Dominant Potentially Affected Habitats in Areas of Concern at Mountain Pass Mine & Mill Site

	Baseline Scenario AOCs										Future Expansion Scenario AOCs		
Potentially Affected Habitats	Overburden Stockpile	North Tailings Pond (P16)	Windblown Tailings	Seepage Collection Ponds (P23)	Lanthanide Storage Ponds (P25b, P28)	Sewage Treatment Pond (P19)	Administration Pond	17 Spring	Jack Meyer's Pond Spring	Wheaton Wash/ Roseberry Spring	Pit lake	East Tailings Pond/ Windblown Tailings	Onsite Evaporation Ponds
Ruderal	•				•								
Desert Scrub		•	•	•	•	•	•	•	•	•	•	•	•
Joshua Tree		•									•		•
Juniper-Blackbrush								•				•	
Freshwater Aquatic							•	•	•	•	•		

Table 3-4a
Constituents of Potential Concern at Mine & Mill Site Areas of Concern: Soils

Constituent	Overburden Stockpile	North Tailings Pond (P-16)	Windblown Tailings	Seepage Collection Pond (P-23)	Lanthanide Storage Ponds (P-25ab, P-28)	Sewage Treatment Pond (P-19)	Administration Pond	17 Spring	Jack Meyer's Pond Spring	Wheaton Wash/ Roseberry Spring	Pit Lake
METALS											
Antimony	●	○	○	●	○	●	○	○	○	●	●
Arsenic		●			●		●		●		
Barium	●		●	●		●	●	●		●	●
Beryllium	●		●		●		●	●	●		●
Cadmium	◉	●			●	●	●		●	●	
Chromium	●			●	○		●				
Cobalt	●										
Copper	●	●	●								●
Lead	●		●	●	●	●	●	●	●	●	●
Manganese	●		●	●	●			●	●		●
Mercury	●	●	●	●		●		●	●	●	●
Molybdenum	●		●	●	●	●	●	●	●	●	●
Nickel	●	●					●		●		
Selenium	●		●	●	●	○	●	●	●	○	●
Silver			●		●	●	●	●	●	●	
Strontium	●		●	●	●	●	●	●	●	●	●
Thallium	○	○				○	●		●	○	○
Vanadium	●	●		●			●				●
Yttrium	●		●	●	●	●	●		●		●
Zinc	●		●								●
LANTHANIDE METALS											
Cerium	●		●	●	●	●	●	●		●	●
Dysprosium	●		●	●	●	●	●	●	●	●	●
Erbium	●		●	●	●	●	●	●	●	●	●
Europium	●		●	●	●	●	●	●	●	●	●
Gadolinium	●		●	●	●	●	●		●	●	●
Holmium	●		●	●	●	●	●		●		●
Lanthanum	●		●	●	●	●	●	●	●	●	●
Lutetium	●		●	●	●		●		●		●
Neodymium	●		●	●	●	●	●	●	●	●	●
Praseodymium	●		●	●	●	●	●	●		●	●
Samarium	●		●		●	●	●	●	●	●	●
Terbium	●		●	●	●	●	●	●	●	●	●
Thulium	●		●	●	●		●		●		●
Ytterbium	●		●	●	●		●		●		●
ACTINIDE METALS											
Thorium	●		●	●		●	●	●		●	●
Uranium	●		●	●	●	○	●	●	●	○	●
RADIONUCLIDES											
Ac-228	●		●	●	●	●	●	●	●	●	●
Bi-214	◉		●	●	●		◉	●	●		●
K-40	●					●				●	
Pb-212	●		●	●	●	●	●	●	●	●	●
Pb-214	●		●	●	●	●	●	●	●	●	●
Ra-223		◉	◉	◉							◉
Ra-224	●		●	●	●	●	●	●	●	●	●
Ra-226	○		●	●	●	○	●	●	●	○	●
Ra-228	●		●	●	●	●	●	●	●	●	●
Th-228	●		◉	●	◉	●	●	◉		●	●
Th-230	●		●	●	◉	●		◉		●	●
Th-232	●		◉	●	◉	●	●	◉		●	●
Tl-208	●		●	●	●	●	●	●	●	●	●
U-234	●		●	●	●	●	●	●	●	●	●
U-235	●		●	●	●	●	●	●	●	○	●
U-238	●		●	●	●	●	●	●	●	●	●

Notes:

◉ = selected as COPC because insufficient sample size for background or AOC data sets to conduct WRS

○ = selected as COPC because background or AOC data set contained > 50% nondetected values

● = selected as COPC by WRS

Table 3-4b
Constituents of Potential Concern at Mine & Mill Site Areas of Concern: Surface Water[1]

Constituents	North Tailings Pond (P-16)	Seepage Collection Pond (P-23a)	Lanthanide Storage Ponds (P-25a, P-28)	Sewage Treatement Pond (P-19)	Administration Pond	17 Spring	Jack Meyer's Pond Spring	Wheaton Wash/Roseberry Spring	Pit Lake
METALS									
Antimony	blue ●		blue ●	gray ●					gray ●
Arsenic	blue ●	blue ●	blue ●		blue ●	gray ●	gray ●		
Barium	blue ●	blue ●	blue ●		blue ●	blue ●	blue ●	green ●	
Beryllium	blue ●		blue ●	gray ●	gray ●	gray ●	gray ●	green ●	
Boron									blue ●
Cadmium	gray ●	gray ●	blue ●	gray ●	gray ●	gray ●		green ●	
Chromium	blue ●	blue ●	blue ●	maroon ●		maroon ●	maroon ●		
Cobalt	blue ●		blue ●						
Copper	blue ●	maroon ●	maroon ●	maroon ●	maroon ●	maroon ●	maroon ●		
Lead	blue ●	blue ●	yellow ●		blue ●	blue ●		green ●	gray ●
Manganese	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●		blue ●
Mercury				yellow ●		yellow ●	gray ●		
Molybdenum	blue ●	blue ●	gray ●		blue ●		blue ●		
Nickel	blue ●		blue ●			blue ●	blue ●		
Selenium	gray ●	gray ●	blue ●		maroon ●	gray ●	gray ●		blue ●
Silver	gray ●	gray ●	gray ●	gray ●	gray ●	gray ●	gray ●	green ●	
Strontium	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	green ●	blue ●
Thallium	gray ●	gray ●	blue ●	gray ●	gray ●	gray ●	gray ●		
Vanadium	blue ●	blue ●	blue ●		maroon ●		gray ●		
Yttrium	blue ●		blue ●	gray ●	gray ●			green ●	gray ●
Zinc			blue ●						gray ●
LANTHANIDE METALS									
Cerium	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●		green ●	
Dysprosium	blue ●	gray ●	blue ●	gray ●	gray ●	gray ●	gray ●		
Erbium	blue ●	gray ●	blue ●	gray ●	gray ●	gray ●	gray ●		
Europium	blue ●	gray ●	blue ●	gray ●	gray ●	gray ●	gray ●		
Gadolinium	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	gray ●		
Holmium	blue ●	gray ●	blue ●	gray ●	gray ●	gray ●	gray ●		
Lanthanum	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	green ●	gray ●
Lutetium	gray ●	gray ●	blue ●	gray ●	gray ●	gray ●	gray ●		
Neodymium	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●		
Praseodymium	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●		
Samarium	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	gray ●		
Terbium	blue ●	gray ●	blue ●	gray ●	gray ●	gray ●	gray ●		
Thulium	gray ●	gray ●	blue ●	gray ●	gray ●	gray ●	gray ●		
Ytterbium	blue ●	gray ●	blue ●	gray ●	gray ●	gray ●	gray ●		
ACTINIDE METALS									
Thorium	blue ●	blue ●	blue ●	gray ●	gray ●	gray ●	gray ●	green ●	
Uranium	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	green ●	blue ●
RADIONUCLIDES									
Ac-228	maroon ●	maroon ●	yellow ●	maroon ●	maroon ●	maroon ●	maroon ●		
Bi-214	maroon ●	maroon ●	maroon ●	maroon ●	maroon ●	maroon ●	maroon ●		yellow ●
K-40	maroon ●	maroon ●	maroon ●	maroon ●	maroon ●	maroon ●	maroon ●		yellow ●
Pb-212	yellow ●	yellow ●	yellow ●	maroon ●	maroon ●	maroon ●	maroon ●		
Pb-214	maroon ●	maroon ●	yellow ●	maroon ●	maroon ●	maroon ●	maroon ●		
Ra-224		maroon ●	maroon ●	maroon ●	maroon ●	maroon ●	maroon ●		
Ra-226			yellow ●						blue ●
Ra-228	blue ●		blue ●	gray ●			blue ●		blue ●
Th-228	blue ●	blue ●	blue ●	blue ●	blue ●	blue ●	gray ●		
Th-230	blue ●		blue ●	gray ●	gray ●	gray ●	gray ●		
Th-232	blue ●	blue ●	blue ●	blue ●	gray ●	blue ●	gray ●		gray ●
Tl-208	yellow ●	yellow ●	yellow ●	yellow ●	yellow ●	yellow ●	yellow ●		
U-234	blue ●	blue ●		blue ●	blue ●	blue ●	blue ●		blue ●
U-235	blue ●			gray ●	gray ●	blue ●	blue ●		blue ●
U-238	blue ●	blue ●		blue ●	blue ●	blue ●	blue ●		blue ●

Notes:

1 Due to the lack of background surface water, background groundwater data (from Well 93-1MW) was used as a surrogate for background surface water.

maroon ● = no site surface water data

yellow ● = selected as COPC because insufficient sample size for background or AOC data sets to conduct WRS

gray ● = selected as COPC because background or AOC data set contained > 50% nondetected values

blue ● = selected as COPC by WRS

green ● = selected as COPC by screening of single sample result against NAWQC.

Table 3-4c
Constituents of Potential Concern at Mine & Mill Site
Areas of Concern: Sediments

Constituents	Administration Pond	17 Spring	Jack Meyer's Pond Spring	Roseberry Spring
METALS				
Antimony	●	●	●	●
Arsenic	●	●	●	●
Barium	●	●	●	●
Beryllium	●	●	●	●
Cadmium	●		●	
Chromium	●			●
Cobalt			●	
Copper			●	
Lead	●	●	●	●
Manganese		●	●	
Mercury	●	●	●	●
Molybdenum	●	●	●	●
Nickel	●		●	●
Selenium	●	●	●	
Silver	●	●	●	●
Strontium	●	●	●	●
Thallium	○	○	○	○
Vanadium			●	
Yttrium	●	●	●	
Zinc	●	●	●	●
LANTHANIDE METALS				
Cerium	●	●	●	●
Dysprosium	●	●	●	●
Erbium	●	●	●	●
Europium	●	●	●	●
Gadolinium	●	●	●	●
Holmium	●	●	●	
Lanthanum	●	●	●	●
Lutetium	◉	◉	◉	◉
Neodymium	●	●	●	●
Praseodymium	●	●	●	●
Samarium	●	●	●	●
Terbium	●	●	●	●
Thulium	○	●	●	○
Ytterbium	●		●	
ACTINIDE METALS				
Thorium	●	●	●	●
Uranium	●	●	●	●
RADIONUCLIDES				
Ac-228	●	●	●	●
Bi-214	◉	◉	◉	◉
K-40		●		●
Pb-212	●	●	●	●
Pb-214	●	●	●	
Ra-224	●	●	●	●
Ra-226	●	●	●	
Ra-228	●	●	●	●
Th-228	●	◉	●	●
Th-230		◉		
Th-232	●	◉		●
Tl-208	●	●	●	●
U-234	●	●	●	●
U-235	○	○	○	○
U-238	●	●	●	●

Notes:
◉ = selected as COPC because insufficient sample size for background or AOC data sets to conduct WRS
○ = selected as COPC because background or AOC data set contained > 50% nondetected values
● = selected as COPC by WRS

Table 3-4d
Constituents of Potential Concern at Mine & Mill Site Areas of Concern: Soils and Surface Water[1]

Constituent	Overburden Stockpile	North Tailings Pond (P-16)	Windblown Tailings	Seepage Collection Pond (P-23)	Lanthanide Storage Ponds (P-25ab, P-28)	Sewage Treatment Pond (P-19)	Administration Pond	17 Spring	Jack Meyer's Pond Spring	Wheaton Wash/ Roseberry Spring	Pit Lake	Future Onsite Evaporation Ponds
METALS												
Antimony	W	G	G	W	G	W	G	G	G	W	W	R
Arsenic		W		S	W		W	S	W			R
Barium	W	S	W	W	S	W	W	W	S	W	W	R
Beryllium	W	S	W		W	S	W	W	W	S	W	R
Boron											S	
Cadmium	Y	W		S	W	W	W	S	W	W		R
Chromium	W	S		W	G	S	W	S	S			R
Cobalt	W	S			S							R
Copper	W	W	W	S	S	S	S	S	S		W	R
Lead	W	S	W	W	W	W	W	W	W	W	W	R
Manganese	W	S	W	W	W	S	S	W	W		W	R
Mercury	W	W	W	W		W		W	W	W	W	R
Molybdenum	W	S	W	W	W	W	W	W	W	W	W	R
Nickel	W	W			S		W	S	W			R
Selenium	W	S	W	W	W	G	W	W	W	G	W	R
Silver		S	W	S	W	W	W	W	W	W		R
Strontium	W	S	W	W	W	W	W	W	W	W	W	R
Thallium	G	G		S	S	G	W	S	W	G	G	R
Vanadium	W	W		W	S		W		S		W	R
Yttrium	W	S	W	W	W	W	W		W	S	W	
Zinc	W		W		S						W	R
LANTHANIDE METALS												
Cerium	W	S	W	W	W	W	W	W		W	W	
Dysprosium	W	S	W	W	W	W	W	W	W	W	W	
Erbium	W	S	W	W	W	W	W	W	W	W	W	
Europium	W	S	W	W	W	W	W	W	W	W	W	
Gadolinium	W	S	W	W	W	W	W	S	W	W	W	
Holmium	W	S	W	W	W	W	W	S	W		W	
Lanthanum	W	S	W	W	W	W	W	W	W	W	W	
Lutetium	W	S	W	W	W	S	W	S	W		W	
Neodymium	W	S	W	W	W	W	W	W	W	W	W	
Praseodymium	W	S	W	W	W	W	W	W	S	W	W	
Samarium	W	S	W	S	W	W	W	W	W	W	W	
Terbium	W	S	W	W	W	W	W	W	W	W	W	
Thulium	W	S	W	W	W	S	W	S	W		W	
Ytterbium	W	S	W	W	W	S	W	S	W		W	
Total Lanthanides												R
ACTINIDE METALS												
Thorium	W	S	W	W	S	W	W	W	S	W	W	R
Uranium	W	S	W	W	W	G	W	W	W	G	W	R
RADIONUCLIDES												
Ac-228	W	S	W	W	W	W	W	W	W	W	W	
Bi-214	Y	S	W	W	W	S	Y	W	W		W	
K-40	W	S		S	S	W	S	S	S	W	S	
Pb-212	W	S	W	W	W	W	W	W	W	W	W	
Pb-214	W	S	W	W	W	W	W	W	W	W	W	
Ra-223		Y	Y	Y							Y	
Ra-224	W		W	W	W	W	W	W	W	W	W	
Ra-226	G		W	W	W	G	W	W	W	G	W	R
Ra-228	W	S	W	W	W	W	W	W	W	W	W	R
Th-228	W	S	Y	W	Y	W	W	Y	S	W	W	R
Th-230	W	S	W	W	Y	W	S	Y	S	W	W	R
Th-232	W	S	Y	W	Y	W	W	Y	S	W	W	R
Tl-208	W	S	W	W	W	W	W	W	W	W	W	
U-234	W	S	W	W	W	W	W	W	W	W	W	R
U-235	W	S	W	W	W	W	W	W	W	G	W	R
U-238	W	S	W	W	W	W	W	W	W	W	W	R

Notes:

1 = COPCs in surface water were also selected as COPCs in soil for ecological receptors exposed to both media in order to compare HQs at AOCs to HQs at reference areas.

2 = COPCs in soil and surface water used to assess risks to all birds except Northern Shoveler (i.e., Gambel's quail, cactus wren, and American kestrel).

Y = selected as COPC in soil because insufficient sample size for background or AOC data sets to conduct WRS

G = selected as COPC in soil because background or AOC data set contained > 50% nondetected values

W = selected as COPC in soil by WRS

S = selected as COPC in surface water (see COPCs in surface water for more detail)

R = selected as COPC because constituent is expected to occur at Onsite Evaporation Ponds and has modeled concentration.

Table 3-4e
Constituents of Potential Concern at Mine & Mill Site
Areas of Concern: Sediments and Surface Water[1]

Constituents	North Tailings Pond (P-16)[2]	Lanthanide Storage Ponds (P-25ab, P-28)[3]	Administration Pond	Pit Lake[4]	Future Onsite Evaporation Ponds
METALS					
Antimony	● (grey)	● (grey)	● (purple)	● (purple)	● (red)
Arsenic	● (light blue)	● (purple)	● (purple)		● (red)
Barium	● (purple)	● (light blue)	● (purple)	● (purple)	● (red)
Beryllium	● (purple)	● (purple)	● (purple)	● (purple)	● (red)
Boron				● (light blue)	
Cadmium	● (light blue)	● (purple)	● (purple)		● (red)
Chromium	● (light blue)	● (grey)	● (purple)		● (red)
Cobalt	● (light blue)	● (light blue)			● (red)
Copper	● (purple)	● (light blue)	● (light blue)	● (purple)	● (red)
Lead	● (purple)	● (purple)	● (purple)	● (purple)	● (red)
Manganese	● (purple)	● (purple)	● (light blue)	● (purple)	● (red)
Mercury	● (purple)		● (purple)	● (purple)	● (red)
Molybdenum	● (purple)	● (purple)	● (purple)	● (purple)	● (red)
Nickel	● (light blue)	● (light blue)	● (purple)		● (red)
Selenium	● (purple)	● (purple)	● (purple)	● (purple)	● (red)
Silver	● (purple)	● (purple)	● (purple)		● (red)
Strontium	● (purple)	● (purple)	● (purple)	● (purple)	● (red)
Thallium	● (light blue)	● (light blue)	● (grey)	● (grey)	● (red)
Vanadium	● (light blue)	● (light blue)	● (light blue)	● (purple)	● (red)
Yttrium	● (purple)	● (purple)	● (purple)	● (purple)	
Zinc	● (purple)	● (light blue)	● (purple)	● (purple)	● (red)
LANTHANIDE METALS					
Cerium	● (purple)	● (purple)	● (purple)	● (purple)	
Dysprosium	● (purple)	● (purple)	● (purple)	● (purple)	
Erbium	● (purple)	● (purple)	● (purple)	● (purple)	
Europium	● (purple)	● (purple)	● (purple)	● (purple)	
Gadolinium	● (purple)	● (purple)	● (purple)	● (purple)	
Holmium	● (purple)	● (purple)	● (purple)	● (purple)	
Lanthanum	● (purple)	● (purple)	● (purple)	● (purple)	
Lutetium	● (purple)	● (purple)	● (yellow)	● (purple)	
Neodymium	● (purple)	● (purple)	● (purple)	● (purple)	
Praseodymium	● (purple)	● (purple)	● (purple)	● (purple)	
Samarium	● (purple)	● (purple)	● (purple)	● (purple)	
Terbium	● (purple)	● (purple)	● (purple)	● (purple)	
Thulium	● (purple)	● (purple)	● (grey)	● (purple)	
Ytterbium	● (purple)	● (purple)	● (purple)	● (purple)	
Total Lanthanides					● (red)
ACTINIDE METALS					
Thorium	● (purple)	● (light blue)	● (purple)	● (purple)	● (red)
Uranium	● (purple)	● (purple)	● (purple)	● (purple)	● (red)
RADIONUCLIDES					
Ac-228	● (purple)	● (purple)	● (purple)	● (purple)	
Bi-214	● (purple)	● (purple)	● (yellow)	● (purple)	
K-40	● (light blue)	● (light blue)	● (light blue)	● (light blue)	
Pb-212	● (purple)	● (purple)	● (purple)	● (purple)	
Pb-214	● (purple)	● (purple)	● (purple)	● (purple)	
Ra-223	● (yellow)			● (yellow)	
Ra-224	● (purple)	● (purple)	● (purple)	● (purple)	
Ra-226	● (purple)	● (purple)	● (purple)	● (purple)	● (red)
Ra-228	● (purple)	● (purple)	● (purple)	● (purple)	● (red)
Th-228	● (yellow)	● (yellow)	● (purple)	● (purple)	● (red)
Th-230	● (purple)	● (yellow)	● (light blue)	● (purple)	● (red)
Th-232	● (yellow)	● (yellow)	● (purple)	● (purple)	● (red)
Tl-208	● (purple)	● (purple)	● (purple)	● (purple)	
U-234	● (purple)	● (purple)	● (purple)	● (purple)	● (red)
U-235	● (purple)	● (purple)	● (grey)	● (purple)	● (red)
U-238	● (purple)	● (purple)	● (purple)	● (purple)	● (red)

Notes:

1 = COPCs in surface water were also selected as COPCs in sediment for ecological receptors exposed to both media in order to compare HQs at AOCs to HQs at reference areas.
2 = Soil at Windblown Tailings used as surrogate for sediment at P-16.
3 = Soil at Lanthanide Storage Ponds (P-25ab, P-28) used as surrogate for sediment at P-25ab, P28.
4 = Soil at Haul Road used as surrogate for sediment at Pit Lake.
● (yellow) = selected as COPC because insufficient sample size for background or AOC data sets to conduct WRS
● (grey) = selected as COPC because background or AOC data set contained > 50% nondetected values
● (purple) = selected as COPC by WRS
● (light blue) = selected as COPC in surface water (see COPCs in surface water for more detail)
● (red) = selected as COPC because constituent is expected to occur at Onsite Evaporation Ponds and has modeled concentration.

Table 3-5

Assessment Endpoints and Measures of Effect for Mountain Pass Mine & Mill Site Areas of Concern

Receptors of Concern	Level of Ecological Organization	Assessment Endpoint	Measures of Effect
Plants			
Grasses and forbs Trees	Community	• Reduction in plant productivity or development under conditions of chronic exposure.	• Production and yield toxicity data for plants (Efroymson *et al.* 1997)
Invertebrates			
Aquatic invertebrates	Community	• Adverse impacts to freshwater aquatic biotic community structure and function under conditions of chronic exposure.	• USEPA National Ambient Water Quality Criteria (USEPA 1999d) • USEPA Tier II Secondary Chronic Values
Sediment-Associated Invertebrates	Community	• Adverse impacts to the freshwater sediment-associated invertebrate community structure and function.	• NOAA ER-Ls (Long *et al.* 1995)
Soil invertebrates	Community	• Adverse impacts to the soil invertebrate community (soil fauna and soil microorganisms) structure and function under conditions of chronic exposure.	• RIVM EIVs for soil invertebrates (van den Berg et al. 1993)
Reptiles			
Desert tortoise	Individual/Population	• Reduction in abundance or persistence of reptile populations under conditions of chronic exposure. • Increased mortality, reproductive impairment, or developmental abnormalities to the desert tortoise and other species of regulatory concern under conditions of chronic exposure.	• Reproductive and developmental toxicity data for reptiles, if available • Reproductive and developmental toxicity data for birds
Birds			
Herbivorous birds	Population	• Reduction in abundance or persistence of herbivorous bird populations under conditions of chronic exposure. • Increased mortality, reproductive impairment, or developmental abnormalities to species of regulatory concern under conditions of chronic exposure.	• Reference toxicity values (RTVs) for Gambel's quail
Insectivorous birds	Population	• Reduction in abundance or persistence of insectivorous bird populations under conditions of chronic exposure. • Increased mortality, reproductive impairment, or developmental abnormalities to species of regulatory concern under conditions of chronic exposure.	• RTVs for the cactus wren
Carnivorous birds	Population	• Reduction in abundance or persistence of carnivorous bird populations under conditions of chronic exposure. • Increased mortality, reproductive impairment, or developmental abnormalities to species of regulatory concern under conditions of chronic exposure.	• RTVs for the American kestrel

Table 3-5
Assessment Endpoints and Measures of Effect for Mountain Pass Mine & Mill Site Areas of Concern

Receptors of Concern	Level of Ecological Organization	Assessment Endpoint	Measures of Effect
Migratory ducks and shorebirds	Population	• Reduction in abundance or persistence of migratory duck or shorebird populations under conditions of chronic exposure. • Increased mortality, reproductive impairment, or developmental abnormalities to species of regulatory concern under conditions of chronic exposure.	• RTVs for the Northern Shoveler •
Mammals			
Herbivorous mammals	Population	• Reduction in abundance or persistence of herbivorous mammal populations under conditions of chronic exposure. • Reduction in abundance or persistence of populations of recreational or commercial species (e.g., bighorn sheep, deer) under conditions of chronic exposure. • Increased mortality, reproductive impairment, or developmental abnormalities to species of regulatory concern under conditions of chronic exposure.	• RTVS for the desert kangaroo rat • RTVs for the bighorn sheep
Insectivorous mammals	Population	• Reduction in abundance or persistence of insectivorous mammal populations under conditions of chronic exposure. • Increased mortality, reproductive impairment, or developmental abnormalities to species of regulatory concern under conditions of chronic exposure.	• RTVs for the desert shrew
Carnivorous mammals	Population	• Reduction in abundance or persistence of carnivorous mammal populations under conditions of chronic exposure. • Increased mortality, reproductive impairment, or developmental abnormalities to species of regulatory concern under conditions of chronic exposure.	• RTVs for the coyote

Definitions:

COPCs = Constituents of potential ecological concern

RIVM EIVs = Dutch National Institute of Public Health and Environmental Protection Ecotoxicological Intervention Values.

RTVS = reference toxicity values are chronic NOAEL-equivalent values that are, for the most part, derived from reproductive and developmental toxicity studies

Table 3-6
Indicator Species for Areas of Concern at Mountain Pass Mine & Mill Site

	Baseline Scenario AOCs										Future Expansion Scenario AOCs		
Indicator Species	Overburden Stockpile	North Tailings Pond (P16)	Windblown Tailings	Seepage Collection Ponds (P23)	Lanthanide Storage Ponds (P25b, P28)	Sewage Treatment Pond (P19)	Administration Pond	17 Spring	Jack Meyer's Pond Spring	Wheaton Wash/ Roseberry Spring	Pit lake	East Tailings Pond/ Windblown Tailings	Evaporation Pond[1]
Plant Community													
Big galleta grass	·	·	·	·	·	·	·	·	·	·	·	·	
Juniper								·	·	·	·		
Invertebrate Community													
Fairy Shrimp							·	·	·	·	·		
Amphipod							·	·	·	·	·		
Earthworm	·	·	·	·	·	·	·	·	·	·	·	·	
Reptiles													
Desert tortoise	·	·	·	·	·	·	·	·	·	·	·	·	
Birds													
Gambel's quail	·	·	·	·	·	·	·	·	·	·	·	·	·
Cactus wren	·	·	·	·	·	·	·	·	·	·	·	·	·
American kestrel	·	·	·	·	·	·	·	·	·	·	·	·	·
Northern shoveler		·			·		·				·	·	·
Mammals													
Desert kangaroo rat	·	·	·	·	·	·	·	·	·	·	·	·	·
Desert shrew	·	·	·	·	·	·	·	·	·	·	·	·	·
Bighorn sheep	·	·	·	·	·	·	·	·	·	·	·	·	
Coyote	·	·	·	·	·	·	·	·	·	·	·	·	

Note:

1 - Future Evaporation Ponds are lined and considered inaccessible to plants and invertebrates. Only surface water and pond solids were evaluated. A surrounding fence also restricts access to the desert tortoise and large mammals.

Table 3-7
Exposure Point Concentrations:
Sample Calculation for Total Lanthanide Metals at Proposed Future Onsite Evaporation Pond

- Based on four years worth of quarterly reporting of wastewater entering the NIEP, the average feed to NIEP for total lanthanide metals was reported as 40 mg/L, at an average flow of 530 GPM. Thus, the average feed to the proposed onsite evaporation ponds for total lanthanide metals is:

  Avg. feed expected to proposed onsite evaporation pond
  = Flow ratio • Measured avg. feed to NIEP
  = (530 gpm / 285 gpm) • 40 mg/l
  = 74 mg/L

- As evaporation of this stream occurs in the ponds, the total TDS is will increase from 55, 789 mg/L to 250,000 mg/L. Therefore, the average predicted onsite evaporation pond water concentration for total lanthanide metals is:

  Avg. predicted onsite evaporation pond water concentration
  = Evaporative concentration factor • Avg. feed expected to proposed onsite evaporation ponds
  = (250,000 mg/L / 55,789 mg/L) • 74 mg[total lanthanide metals]/L
  = 333 mg[total lanthanide metals]/L

- Since 250,000 mg/L is ¼ the strength of 1,000,000 mg/kg (pure solid), the average predicted onsite evaporation pond solid concentration for total lanthanide metals is:

  Avg. predicted onsite evaporation pond solids concentration
  = Avg. feed expected to new onsite evaporation ponds • (1,000,000 mg/ L / 250,000 mg/kg)
  = 333 mg/L • (1,000,000 mg/ L / 250,000 mg/kg)
  = 1333 mg/kg

Table 3-8
Wildlife Exposure Factors for Indicator Species

Guild Common Name	Body Weight [FW] (kg)	Body length (cm)	Body width (diameter) (cm)	Surface Area (cm^2)	Food Ingestion Rate [DW] (kg/d)	Drinking Rate (mL/d)	Inhalation Rate (m^3/d)	Food Item	Diet Proportions [% DW] Soil	Plant	Invert	Mammal	Soil Depth (ft bgs)	Home Range or Territory (ha)	Source / Comment
Plants															
Shallow-Rooted Plants															
Big galleta grass	-	68	0.25	17	-	-	-	-	-	-	-	-	0 - 0.5 ft	-	1
Deeper-Rooted Plants															
Juniper	-	530	25	13250	-	-	-	-	-	-	-	-	0 - 20 ft	-	2
Invertebrates															
Aquatic Invertebrates															
Fairy shrimp	-	2	0.5	1	-	-	-	filters food from water column	-	-	-	-	-	-	3
Sediment-Associated Invertebrates															
Amphipod	-	2	0.5	1	-	-	-	detritivore	100%	-	-	-	-	-	3
Soil Invertebrates															
Earthworm	-	10	0.5	5	-	-	-	detritivore	100%	-	-	-	0 - 0.5 ft	-	4
Reptiles															
Desert tortoise	3.1	26	17.5	455	0.014	6.9	0.19	brome, forbs, grasses, flowers	9%	91%	0%	0%	0 - 0.5 ft	22	28,29,30,32,35
Birds															
Northern shoveler	0.59	48	12	576	0.041	41	0.27	aquatic invertebrates	3%	0%	97%	0%	0 - 0.5 ft	31	5,6,7,8,9,10
Gambel's quail	0.162	28	9.0	252	0.018	17	0.10	forbs, shrubs, grass seeds	9%	91%	0%	0%	0 - 0.5 ft	3.3	7,8,9,11,12,13
Cactus wren	0.039	22	6.0	132	0.0089	6.7	0.062	insects, spiders, other invertebrates	9%	0%	91%	0%	0 - 0.5 ft	1.9	5,6,7,9,13,14
American kestrel	0.121	27	9.0	243	0.012	14	0.084	small mammals	2%	0%	0%	98%	0 - 0.5 ft	22	7,11,16,17,31,34
Mammals															
Desert kangaroo rat	0.10	15	6	88	0.0085	13	0.012	plants, seeds	8%	92%	0%	0%	0 - 0.5 ft	13	7,9,15,17,18,19,20,33
Desert shrew	0.004	5.8	2.4	14	0.0006	1.03	0.009	worms, insects	8%	0%	92%	0%	0 - 0.5 ft	2.2	7,15,16,17,20,21
Bighorn sheep	42	132	36	4752	1.3	2861	11	grasses, sedges, forbs	2%	98%	0%	0%	0 - 0.5 ft	1,260	7,8,15,23,24,25
Coyote	14	87	25	2175	0.60	1065	4.5	small mammals	3%	0%	0%	97%	0 - 0.5 ft	3,150	7,8,9,17,26,27

Sources:

1 Plant length and diameter from Hickman (1993).
2 Plant length and diameter from Petrides (1992).
3 Body length and width obtained from Thelander (1994).
4 Body length and width assumed.
5 Body weight taken from Dunning (1984).
6 Body length taken from National Geographic Society (1987).
7 Body width assumed.
8 Food ingestion, drinking, and inhalation rates were calculated using allometric regression equations (U.S. EPA 1993). The following equations were used: for Northern shoveler, "all birds" for food ingestion, "all birds" for water ingestion, and "all non-passerines" for inhalation rate; for Gambel's quail, "all birds" for food ingestion, "all birds" for water ingestion, and "all non-passerines" for inhalation rate; for Bighorn sheep, "herbivores" for food ingestion, "all mammals" for water ingestion, and "all mammals" for inhalation rate; and for Coyote, "all mammals" for food ingestion, "all mammals" for water ingestion, and "all mammals" for inhalation rate.
9 Food item and territory or home range from Zeiner *et al.* (1988a).
10 Soil diet proportion taken from Beyer *et al*. (1994). Mallard used as surrogate for Northern shoveler.
11 Body weights were taken from average of female mean body weights (measure in fall for American kestrel) in U.S. EPA (1993).
12 Effective radius from Udvardy (1994).
13 Soil diet proportion was obtained from the estimate of soil ingestion by the Wild turkey, in Beyer *et al.* (1994).
14 Food ingestion, drinking, and inhalation rates were calculated using allometric regression equations (U.S. EPA 1993), "passerines" for food ingestion, "all birds" for water ingestion, and "all non-passerines" for inhalation rate. Inhalation rate scaled to compensate for higher metabolic rate of passerine, using ratio of field metabolic rate (FMR) for passerines to FMR for non-passerines.
15 Body weight taken from male and/or female mean body weights in Silva & Downing (1995).
16 Food item and territory or home range from U.S. EPA (1993).
17 Mean of body lengths from Burt and Grossenheider (1980).
18 Food ingestion rate was calculated using an average ingestion rate for the Great Basin kangaroo rat (Nagy 1987) and scaling to body weight of Desert kangaroo rat.
19 Inhalation rate was calculated using inhalation rate for Stephen's kangaroo rat (Morgan and Price 1992) and scaling to body weight of Desert kangaroo rat.
20 Soil diet proportion was obtained from the estimate of soil ingestion by the black-tailed prairie dog, in Beyer *et al.* (1994).
21 Food ingestion, drinking, and inhalation rates were based on rates of the short-tailed shrew and scaled to compensate for different metabolic rates (U.S. EPA 1993).
22 Soil diet proportion was obtained from the estimate of soil ingestion by the meadow vole, in Beyer *et al.* (1994).
23 Mean of body lengths from Whitaker (1997).
24 Food item and home range from Zeiner *et al.* (1988a). Home range calculated from average summer movement, since water requirements limit range.
25 Soil diet proportion was obtained from the estimate of soil ingestion by the white-tailed deer, in Beyer *et al.* (1994).
26 Mean of body weight was taken from Jameson and Peeters (1983).
27 Soil diet proportion was obtained from the estimate of soil ingestion by the red fox, in Beyer *et al.* (1994).
28 Body weight, length, and width were obtained from Peter Woodman, desert tortoise biologist (Kiva Biology) (pers.comm 1999).
29 Food ingestion and drinking rates were obtained from Nagy and Medica (1986).
30 Home range was obtained from Turner *et al*. (1981).
31 Food ingestion, drinking, and inhalation rates were obtained from U.S. EPA (1993).
32 Inhalation rate was obtained from *An Assessment of Radiological Impacts on the Desert Tortoise by the Proposed LLRW Facility at Ward Valley* (U.S.EPA 1995).
33 Drinking rate was calculated using allometric regression equation, "all mammals" (U.S. EPA 1993).
34 Soil diet proportion was obtained from the estimate of soil ingestion by the Cooper's hawk, in Sample *et al.* (1997).
35 Soil diet proportion was obtained from the estimate of soil ingestion by the box turtle, multiplied by 2 for conservatism, in Beyer *et al.* (1994).

Table 3-9
Site Presence Indices for Indicator Species

Receptors	Overburden Stockpile baseline	Overburden Stockpile future	Other Mine & Mill Site AOCs	Far-Ranging Other AOCs baseline	Far-Ranging Other AOCs future
Plants	1.0	1.0	1.0	—	—
Aquatic invertebrates	—	—	1.0	—	—
Sediment-associated invertebrates	—	—	1.0	—	—
Soil invertebrates	1.0	1.0	1.0	—	—
Desert tortoise	1.0	1.0	0.59	—	—
Birds					
Gambel's quail	1.0	1.0	1.0	—	—
Cactus wren	1.0	1.0	1.0	—	—
American kestrel	1.0	1.0	0.59	—	—
Northern shoveler	—	—	1.0	—	—
Mammals					
Desert kangaroo rat	1.0	1.0	1.0	—	—
Desert shrew	1.0	1.0	1.0	—	—
Bighorn sheep	—	—	—	0.12	0.20
Coyote	—	—	—	0.05	0.08

Table 3-10a
Sample Exposure Calculation: Metals [Lead]

Receptor:	Coyote (consuming herbivorous prey)
Location:	Mine and Mill Site (wide-ranging species) - Baseline Scenario
Analyte:	Lead
Soil EPC (mg/kg):	3.63E+03
Surface Water EPC (ug/l):	1.10E+04

Exposure Factors for Coyote	
Body Weight (kg):	14
Ingestion Rate (mg/day DW):	6.01E+05
Inhalation Rate (m^3/day):	4.5
Drinking Rate (ml/day):	1065
Animal Diet Proportion:	97.2%
Soil Diet Propotion:	2.8%
Site Area (ha)[a]:	156
Foraging Area (ha):	3150
Site Presence Index (SPI):	0.0495

Mean Prey Tissue Concentration:

ln (whole body) = B0 + B1(ln[soil])
ln (whole body) = -0.6114 + 0.5181(ln[3.63E+03])
whole body concentration = **37.93 mg/kg**

Food Ingestion Dose:

Food Ingestion Dose = Prey Tissue Conc. * Ingestion Rate * Animal Diet Proportion * SPI * (1/Body Weight) * units conversion factor
= 37.93 mg/kg DW * 6.01E+05 mg/day DW * 0.972 * 0.0495 * (1/14 kg) * 1E-06
= 7.8E-02 mg/kg-day

Soil Ingestion Dose:

Soil Ingestion Dose = Soil EPC * Ingestion Rate * Soil Diet Proportion * SPI * (1/Body Weight) * Bioaccessibility factor * units conversion factor
= 3.63E+03 mg/kg * 6.01E+05 mg/day DW * 0.028 * 0.0495 * (1/14 kg) * 0.56 * 1E-06
= 1.2E-01 mg/kg-day

Drinking Water Dose:

Drinking Water Dose = Surface Water EPC * Drinking Rate * SPI * (1/Body Weight) * units conversion factor
= 1.10E+04 ug/l * 1065 ml/day * 0.0495 * (1/14 kg) * 1E-06
= 4.1E-02 mg/kg-day

Total Ingestion Dose:

Total Ingestion Dose = Food Ingestion Dose + Soil Ingestion Dose + Drinking Water Dose
= 7.8E-02 mg/kg-day + 1.2E-01 mg/kg-day + 4.1E-02 mg/kg-day
= **2.4E-01 mg/kg-day**

Notes:

a - Site area for coyote calculated by summing areas of all baseline AOCs, i.e., 12 AOCs * 13 ha/AOC = 156 ha.

Table 3-10b
Sample Exposure Calculation: Metals [Lanthanum]

Receptor:	Coyote (consuming insectivorous prey)
Location:	Mine and Mill Site (wide-ranging species) - Baseline Scenario
Analyte:	Lanthanum
Soil EPC (mg/kg):	3.80E+05
Surface Water EPC (ug/l):	4.83E+06

Exposure Factors for Coyote	
Body Weight (kg):	14
Ingestion Rate (mg/day DW):	6.01E+05
Inhalation Rate (m^3/day):	4.5
Drinking Rate (ml/day):	1065
Animal Diet Proportion:	97.2%
Soil Diet Propotion:	2.8%
Site Area (ha)[a]:	156
Foraging Area (ha):	3150
Site Presence Index (SPI):	0.0495

Mean Prey Tissue Concentration:

Tissue Concentration = Total Prey Ingested Dose (mg/kg-day)[b] * Body Weight$_{prey}$ * BTF
= 5.4E+04 * 0.004 * 3.00E-04
= 6.5E-02 mg/kg

Food Ingestion Dose:

Food Ingestion Dose = Tissue Conc. * Ingestion Rate * Animal Diet Proportion * SPI * (1/Body Weight) * units conversion factor
= 6.5E-02 mg/kg DW * 6.01E+05 mg/day DW * 0.972 * 0.0495 * (1/14 kg) * 1E-06
= 1.3E-04 mg/kg-day

Soil Ingestion Dose:

Soil Ingestion Dose = Soil EPC * Ingestion Rate * Soil Diet Proportion * SPI * (1/Body Weight) * Bioaccessibility factor * units conversion factor
= 3.80E+05 mg/kg * 6.01E+05 mg/day DW * 0.028 * 0.0495 * (1/14 kg) * 0.06 * 1E-06
= 1.4E+00 mg/kg-day

Drinking Water Dose:

Drinking Water Dose = Surface Water EPC * Drinking Rate * SPI * (1/Body Weight) * units conversion factor
= 4.83E+06 ug/l * 1065 ml/day * 0.0495 * (1/14 kg) * 1E-06
= 1.8E+01 mg/kg-day

Total Ingestion Dose:

Total Ingestion Dose = Food Ingestion Dose + Soil Ingestion Dose + Drinking Water Dose
= 1.3E-04 mg/kg-day + 1.4E+00 mg/kg-day + 1.8E+01 mg/kg-day
= **2.0E+01 mg/kg-day**

Table 3-10b
Sample Exposure Calculation: Metals [Lanthanum]

Notes:

a - Site area for coyote calculated by summing areas of all baseline AOCs, i.e., 12 AOCs * 13 ha/AOC = 156 ha.

b - Coyote assumed to ingest desert shrew as insectivorous prey. See below for calculation of total prey ingested dose:

Exposure Factors for Desert Shrew	
Body Weight (kg):	0.004
Ingestion Rate (mg/day DW):	5.98E+02
Inhalation Rate (m^3/day):	8.53E-03
Drinking Rate (ml/day):	1.03E+00
Animal Diet Proportion:	92.3%
Soil Diet Propotion:	7.7%
Site Area (ha):	13
Foraging Area (ha):	2.2
Site Presence Index (SPI):	1
Soil Density:	1.7
Soil-to-air Transfer Factor:	1.08E-07

Earthworm Tissue Concentration

= Soil EPC * Uptake Factor
= 3.80E+05 * 1
= 3.80E+05 mg/kg

Food Ingestion Dose

= Tissue Conc. * Ingestion Rate * Animal Diet Proportion * SPI * (1/Body Weight)
* units conversion factor
= 3.80E+05 * 5.98E+02 * 0.923 * 1 * (1/0.004) * 1E-06
= 5.2E+04 mg/kg-day

Soil Ingestion Dose

= Soil EPC * Ingestion Rate * Soil Diet Proportion * SPI * (1/Body Weight)
* Bioaccessibility factor * units conversion factor
= 3.80E+05 * 5.98E+02 * 0.077 * 1 * (1/0.004) * 0.06 * 1E-06
= 2.6E+02 mg/kg-day

Drinking Water Dose

= Surface Water EPC * Drinking Rate * SPI * (1/Body Weight) * units conversion factor
= 4.83+06 * 1.03E+00 * 1 * (1/0.004) * 1E-06
= 1.2E+03 mg/kg-day

Fugitive Dust Ingestion Dose

= Soil EPC * Inhalation Rate * Soil Density * Soil-to-air Transfer Factor * SPI * (1/Body Weight)
* Bioaccessibility Factor * units conversion factor
= 3.80E+05 * 8.53E-03 * 1.7 * 1.08E-07 * 1 * (1/0.004) * 0.06 * 1E+03
= 8.9E+00 mg/kg-day

Total Ingestion Dose

= Food Ingestion Dose + Soil Ingestion Dose + Drinking Water Dose + Fugitive Dust Ingestion Dose
= 5.2E+04 + 2.6E+02 + 1.2E+03 + 8.9E+00
= 5.4E+04 mg/kg-day

Table 3-11
Sample Exposure Calculation: Radionuclides

Receptor:	American Kestrel	
Location:	Mine and Mill Site	
Analyte:	Radiation Dose	
Soil EPC (pCi/kg):	Thorium + d	29200
	Uranium + d	45500
	Actinium + d	19400
Surface Water EPC (pCi/L):	Thorium + d	699
	Uranium + d	196
	Actinium + d	93.4

Exposure Factors for American Kestrel	
Body Weight (g):	121
Ingestion Rate (kg/year):	4.37
Inhalation Rate (m3/year):	30.6
Drinking Rate (L/year)):	5.1
Animal Diet Proportion:	98%
Soil Diet Proportion:	2%
Site Presence Index:	0.59

Mean Prey Tissue Concentration:

Whole body concentration = Soil EPC x Bioconcentration Factor
Thorium + d = 29200 (pCi/kg) x 5.46 = **159432 (pCi/kg)**
Uranium + d = 45500 (pCi/kg) x 3.39 = **154245 (pCi/kg)**
Actinium + d = 19400 (pCi/kg) x 0.74 = **14356 (pCi/kg)**

Direct Irradiation Dose:

Direct Irradiation Dose = Soil EPC x Conversion factor for direct irradiation x Site Presence Index
Thorium + d = 29200 (pCi/kg) x 0.0601 (mrad kg / pCi year) x 0.59 = **1035 (mrad/year)**
Uranium + d = 45500 (pCi/kg) x 0.0550 (mrad kg / pCi year) x 0.59 = **1476 (mrad/year)**
Actinium + d = 19400 (pCi/kg) x 0.0149 (mrad kg / pCi year) x 0.59 = **171 (mrad/year)**
Total Direct Irradiation Dose = 1035 (mrad/year) + 1476 (mrad/year) + 171 (mrad/year) = **2682 (mrad/year)**

Inhalation Dose:

Inhalation Dose = Inhalation Rate x Soil EPC x Soil Density x Soil to Air tranfer factor x Site Presence Index x Dose Conversion Factor
Thorium + d = 30.6 (m3/year) x 29200 (pCi/kg) x 1500 (kg/m3) x 1.08E-7 x 0.59 x 2.12 (mrad/pCi) = **181 (mrad/year)**
Uranium + d = 30.6 (m3/year) x 45500 (pCi/kg) x 1500 (kg/m3) x 1.08E-7 x 0.59 x 1.60 (mrad/pCi) = **212 (mrad/year)**
Actinium + d = 30.6 (m3/year) x 19400 (pCi/kg) x 1500 (kg/m3) x 1.08E-7 x 0.59 x 1.43 (mrad/pCi) = **81 (mrad/year)**
Total Inhalation Dose = 181 (mrad/year) + 212 (mrad/year) + 81 (mrad/year) = **474 (mrad/year)**

Table 3-11
Sample Exposure Calculation: Radionuclides

Drinking Water Dose:

Drinking Water Dose =	Ingestion Rate x Water EPC x Site Presence Index x Dose Conversion Factor
Thorium + d =	5.1 (L/year) x 699 (pCi/L) x 0.59 x 0.708 (mrad/pCi) = **1489 (mrad/year)**
Uranium + d =	5.1 (L/year) x 196 (pCi/L) x 0.59 x 0.532 (mrad/pCi) = **314 (mrad/year)**
Actinium + d =	5.1 (L/year) x 93 (pCi/L) x 0.59 x 0.095 (mrad/pCi) = **27 (mrad/year)**
Total Drinking Water Dose =	1489 (mrad/year) + 314 (mrad/year) + 27 (mrad/year) = **1830 (mrad/year)**

Soil Ingestion Dose:

Soil Ingestion Dose =	Ingestion Rate x Soil EPC x Soil Diet Proportion x Site Presence Index x Dose Conversion Factor
Thorium + d =	4.37 (kg/year) x 29200 (pCi/kg) x 0.02 x 0.59 x 0.708 (mrad/pCi) = **1066 (mrad/year)**
Uranium + d =	4.37 (kg/year) x 45500 (pCi/kg) x 0.02 x 0.59 x 0.532 (mrad/pCi) = **1248 (mrad/year)**
Actinium + d =	4.37 (kg/year) x 19400 (pCi/kg) x 0.02 x 0.59 x 0.095 (mrad/pCi) = **95 (mrad/year)**
Total Soil Ingestion Dose =	1066 (mrad/year) + 1248 (mrad/year) + 95 (mrad/year) = **2409 (mrad/year)**

Food Ingestion Dose:

Food Ingestion Dose =	Ingestion Rate x Mean Prey Tissue Concentration x Food Diet Proportion x Site Presence Index x Dose Conversion Factor
Thorium + d =	4.37 (kg/year) x 159520 (pCi/kg) x 0.98 x 0.59 x 0.708 (mrad/pCi) = **285370 (mrad/year)**
Uranium + d =	4.37 (kg/year) x 154388 (pCi/kg) x 0.98 x 0.59 x 0.532 (mrad/pCi) = **207532 (mrad/year)**
Actinium + d =	4.37 (kg/year) x 14440 (pCi/kg) x 0.98 x 0.59 x 0.095 (mrad/pCi) = **3466 (mrad/year)**
Total Food Ingestion Dose =	1066 (mrad/year) + 1248 (mrad/year) + 95 (mrad/year) = **496368 (mrad/year)**

Total Absorbed Dose:

Total Absorbed Dose =	Direct Irradiation Dose + Inhalation Dose+ Drinking Water Dose + Soil Ingestion Dose + Food Ingestion Dose
=	2682 (mrad/year) + 474 (mrad/year) + 1830 (mrad/year) + 2409 (mrad/year) + 496368 (mrad/year)
=	**503763 (mrad/year)**

Table 3-12
Reference Toxicity Values[a] for Indicator Species

	RTVs (mg/kg-d)									RTVs (mg/kg$_{soil}$)		RTVs (µg/L)		RTVs (mg/kg$_{sedimt}$)
Chemical	Desert Kangaroo Rat	Desert Shrew	Bighorn Sheep	Coyote	Northern Shoveler	Gambel's Quail	Cactus Wren	American Kestrel	Desert Tortoise	Soil Invertebrates	Plants [all]	Trees[b]	Aquatic Biota	Sediment Biota
METALS														
Antimony	0.092	0.11	0.064	0.068							5		30	2.0
Arsenic	0.63	0.96	0.30	0.34	4.9	3.8	2.9	3.6	0.3	40	10	1	150	8.2
Barium	7.3	17	1.6	2.1	143	110	83	104	10	625	500		4	
Beryllium	0.53	0.64	0.37	0.39							10	500	0.66	
Boron											-[c]	1000	1.6	
Cadmium	1.2	2.6	0.30	0.39	2.0	1.5	1.1	1.4	0.1	12	4	100	2.2[d]	1.2
Chromium	2.6	3.2	1.8	2.0	0.86	0.66	0.50	0.63	0.06	230	88	50	74[d]	81
Cobalt	1.3	1.5	0.88	0.94						240	38	60	23	
Copper	13	16	9.4	10	3.4	2.6	2.0	2.5	0.24	190	93	50	9.0[d]	34
Lead	1.1	1.3	0.74	0.79	5.2	4.0	3.0	3.8	0.36	290	50	20	2.5[d]	47
Manganese	93	113	65	69	1488	1149	864	1084	104		2250	4000	120	
Mercury	1.1	1.11	0.95	0.97	0.59	0.46	0.34	0.43	0.041	10	0.30	5	0.77	0.15
Molybdenum	0.19	0.23	0.13	0.14	8.2	6.4	4.8	6.0	0.57	480	2	500	370	
Nickel	16	19	11	12	73	56	42	53	5.1	210	30	500	52[d]	21
Selenium	0.15	0.14	0.16	0.16	0.45	0.35	0.26	0.33	0.031		1	700	5	
Silver	23	28	16	17							2	100	0.34	1.0
Strontium	197	240	138	147							1.2		1500	
Thallium	0.0094	0.018	0.003	0.0037							1	20	12	
Vanadium	0.22	0.27	0.15	0.16	1.0	0.77	0.58	0.72	0.069		75	200	20	
Zinc	177	754	12	20	11	8.8	6.6	8.3	0.8	720	50	400	120[d]	150
LANTHANIDE METALS & YTTRIUM														
Lanthanides, Total	1.6	1.9	1.1	1.2						50				
Yttrium	1.3	1.5	0.88	0.94										
ACTINIDE METALS														
Thorium														
Uranium	2.8	3.4	2.0	2.1	14	11	8	10	1.0		5	40000	2.6	
RADIONUCLIDES (rad/day)														
	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.010	0.10	0.10	0.10	0.10	0.10

Notes:

a = Further detail on references, scaling factors, uncertainty factors, etc. for listed values are provided in Appendix I Final Work Plan (Appendix D.5, Tables D.5-2 through D.5-7).

b = uptake from shallow groundwater by trees only

c = Boron was not identified as a COPC in soil.

d = for hardness = 100 mg[$CaCO_3$]/L

(grey shading) Insufficient toxicity data to derive an RTV

Table 3-13
Risk Estimates for Aquatic Invertebrate Communities at Mine & Mill Site Areas of Concern

	HQs due to Bioaccumulation of COPCs					
		Baseline Scenario AOCs				Future Expansion Scenario AOC
COPC	Background GW	Administration Pond	17 Spring	Jack Meyer's Pond Spring	Wheaton Wash / Roseberry Spring	Pit Lake
Metals						
Antimony	NA	-	-	-	-	3.3E-2
Arsenic	NA	5.4E-2	4.7E-2	1.5E-1	-	-
Barium	3.3E+1	6.3E+1	1.5E+3	3.3E+2	3.5E+1	-
Beryllium	NA	1.1E+0	5.0E-1	5.4E+0	1.1E+0	-
Boron	1.8E+2	-	-	-	-	3.1E+2
Cadmium	NA	1.3E-1	2.5E-2	-	1.3E+0	-
Chromium	NA	-	-	-	-	-
Cobalt	NA	-	-	-	-	-
Copper	NA	-	-	-	-	-
Lead	NA	1.3E+0	4.2E+0	-	4.1E-1	1.3E+0
Manganese	NA	7.3E-1	4.3E+0	1.3E+1	-	1.2E+0
Mercury	3.4E+0	-	-	1.8E-1	-	-
Molybdenum	NA	5.7E-1	-	4.8E-2	-	-
Nickel	NA	-	7.4E-2	5.4E-2	-	-
Selenium	5.0E-1	-	2.8E-2	1.4E+0	-	1.9E+0
Silver	NA	2.0E+0	2.0E+0	9.8E+0	3.9E+1	-
Strontium	2.7E-1	1.5E+0	4.3E+0	1.2E+2	2.0E+1	7.3E+1
Thallium	NA	5.9E-2	5.9E-2	2.9E-1	-	-
Vanadium	NA	-	-	1.8E+0	-	-
Yttrium	NA	-	-	-	-	-
Zinc	NA	-	-	-	-	2.2E-1
Total Metals [1]	2.1E+2	7.0E+1	1.5E+3	4.8E+2	9.7E+1	3.8E+2
Future Total Metals [1] *(using background Ba and Sr concentrations at AOCs)*		3.9E+1	4.4E+1	6.4E+1	7.5E+1	
Lanthanide Metals						
Cerium	NR	NR	NR	-	NR	NR
Lanthanum	NR	NR	NR	NR	NR	NR
Neodymium	NR	NR	NR	NR	NR	NR
Praseodymium	NR	NR	NR	NR	NR	NR
Samarium	NR	NR	NR	NR	NR	NR
Total Lanthanides [1]						
Actinide Metals						
Thorium	NR	NR	NR	NR	NR	NR
Uranium	1.3E+0	5.8E+0	3.4E+1	3.7E+1	8.5E+0	8.5E+1
Radionuclides						
Total Radionuclides		P	3.0E-2	5.0E-2	P	8.0E-2
GRAND SUM[1]	2.1E+2	7.6E+1	1.5E+3	5.1E+2	1.1E+2	
FUTURE GRAND SUM[1]	1.3E+0	4.4E+1	7.8E+1	1.0E+2	8.3E+1	4.7E+2

\- = Not a COPC
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

1 - Summed HQs are provided only to facilitate spatial comparisons
—summed HQ values are not intended to demonstrate the magnitude of total risk.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-14
Risk Estimates for Sediment-Associated Invertebrate Communities at Mine & Mill Site Areas of Concern

	HQs due to Bioaccumulation of COPCs					
		Baseline Scenario AOCs				Future Expansion Scenario
COPC	Background Sediment	Administration Pond	17 Spring	Jack Meyer's Pond Spring	Wheaton Wash / Roseberry Spring	Pit Lake
Metals						
Antimony	NA	6.5E-1	5.5E-1	6.9E+0	2.1E-1	2.4E+0
Arsenic	2.8E-1	1.2E+0	6.0E-1	9.0E+0	8.8E-1	-
Barium	NR	NR	NR	NR	NR	NR
Beryllium	NR	NR	NR	NR	NR	NR
Boron	NR	-	-	-	-	-
Cadmium	1.8E-1	6.1E-1	-	3.7E-1	-	-
Chromium	1.5E-1	5.4E-1	-	-	3.2E-1	-
Cobalt	NR	NR	NR	NR	NR	-
Copper	4.0E-1	-	-	2.2E+0	-	8.2E-1
Lead	1.9E-1	8.3E+0	1.1E+1	3.6E+1	3.8E+0	3.9E+1
Manganese	NR	-	NR	NR	-	NR
Mercury	1.0E-1	9.4E+1	1.1E+0	6.7E+0	1.6E+0	2.3E+0
Molybdenum	NR	NR	NR	NR	NR	NR
Nickel	5.0E-1	1.5E+0	-	2.6E+0	1.2E+0	-
Selenium	NR	NR	NR	NR	-	NR
Silver	NA	9.6E-1	9.3E-2	1.4E-1	1.3E-1	-
Strontium	NR	NR	NR	NR	NR	NR
Thallium	NR	NR	NR	NR	NR	NR
Vanadium	NR	-	-	NR	-	NR
Yttrium	NR	NR	NR	NR	-	NR
Zinc	4.4E-1	2.2E+0	1.2E+0	3.5E+0	8.5E-1	1.4E+0
Total Metals [1]	2.2E+0	1.1E+2	1.5E+1	6.8E+1	8.9E+0	4.6E+1
Lanthanide Metals						
Cerium	NR	NR	NR	NR	NR	NR
Lanthanum	NR	NR	NR	NR	NR	NR
Neodymium	NR	NR	NR	NR	NR	NR
Praseodymium	NR	NR	NR	NR	NR	NR
Samarium	NR	NR	NR	NR	NR	NR
Total Lanthanides						
Actinide Metals						
Thorium	NR	NR	NR	NR	NR	NR
Uranium	NR	NR	NR	NR	NR	NR
Radionuclides						
Total Radionuclides [1]	1.0E-2	P	5.0E-2	3.0E-2	P	8.0E-2
GRAND SUM [1]	2.3E+0	1.1E+2	1.5E+1	6.8E+1	8.9E+0	4.6E+1

\- = Not a COPC
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

1 - Summed HQs are provided only to facilitate spatial comparisons
—summed HQ values are not intended to demonstrate the magnitude of total risk.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-15
Risk Estimates for Desert Plant Communities at Mine & Mill Site Areas of Concern

	HQs Due to Bioaccumulation of COPCs																
	Background					Baseline Scenario AOCs										Future Expansion Scenario AOCs	
COPEC	Bedrock	Older Alluvium	Younger Alluvium	Shonkenite	Mixed	Overburden Stockpile[1]	North Tailings Pond (P-16)[2]	Windblown Tailings[3]	Seepage Collection Pond (P-23)[4]	Lanthanide Storage Ponds (P-25 and P-28)[3]	Sewage Treatment Pond (P-19)[5]	Administration Pond[6]	17 Spring[3]	Jack Meyer's Pond Spring[6]	Wheaton Wash / Roseberry Spring[7]	Pit Lake[2]	East Tailings Pond
Metals																	
Antimony	6.6E-2	1.4E-2	5.4E-2	2.4E-2	NA	1.9E+0	7.8E-2	9.1E-1	3.8E-1	1.7E+0	2.0E-1	2.6E-1	2.2E-1	1.0E+0	1.0E-1	9.8E-1	9.1E-1
Arsenic	1.7E+0	8.1E-1	7.6E-1	5.0E-1	2.0E+0	-	2.9E+0	-	-	3.3E+0	-	1.0E+0	-	1.8E+0	-	-	-
Barium	4.8E+0	4.9E+0	9.0E-1	8.4E+0	1.5E+0	1.2E+1	-	1.5E+1	1.1E+1	-	4.8E+0	1.8E+1	1.3E+1	-	5.9E+0	1.4E+1	1.5E+1
Beryllium	2.0E-1	8.3E-2	6.8E-2	8.8E-1	1.2E-1	1.3E+0	-	1.9E-1	-	2.1E-1	-	2.0E-1	8.9E-2	1.9E-1	-	4.6E-1	1.9E-1
Cadmium	7.8E-2	8.4E-2	4.0E-2	3.0E-2	3.8E-2	1.1E-1	1.1E-1	-	-	1.9E-1	2.1E-1	1.8E-1	-	1.1E-1	1.1E-1	-	-
Chromium	2.1E-1	2.2E-1	1.9E-1	3.3E+0	3.3E-1	9.5E-1	-	-	4.4E-1	3.4E-1	-	1.1E+0	-	-	-	-	-
Cobalt	3.9E-1	2.3E-1	2.0E-1	7.2E-1	6.7E-1	6.3E-1	-	-	-	-	-	-	-	-	-	-	-
Copper	2.5E-1	2.0E-1	1.7E-1	4.9E-1	4.0E-1	3.3E-1	3.6E-1	2.5E-1	-	-	-	-	-	-	-	3.0E-1	2.5E-1
Lead	2.2E+0	2.6E+0	4.8E-1	1.7E+0	1.4E+0	7.3E+1	-	3.9E+1	5.3E+1	9.0E+0	1.8E+1	7.8E+0	1.3E+1	2.3E+1	2.8E+0	3.7E+1	3.9E+1
Manganese	4.1E-1	2.0E-1	1.4E-1	2.4E-1	3.2E-1	1.2E+0	-	2.0E+0	1.7E+0	3.5E-1	-	-	3.3E-1	8.3E+0	-	1.9E+0	2.0E+0
Mercury	3.5E-1	1.9E-1	1.3E-1	6.5E-1	2.1E-1	8.8E-1	7.8E-1	1.1E+0	8.2E-1	-	9.8E+0	-	9.9E-1	2.6E+0	3.0E+0	1.1E+0	1.1E+0
Molybdenum	5.6E-1	2.3E-1	2.7E-1	1.5E-1	1.7E-1	5.1E+0	-	2.4E+0	2.2E+1	1.1E+1	6.0E+0	3.8E+1	1.2E+0	2.7E+0	4.2E-1	3.8E+0	2.4E+0
Nickel	6.5E-1	5.2E-1	6.2E-1	9.5E+0	1.5E+0	2.1E+0	2.1E+0	-	-	-	-	2.4E+0	-	7.9E-1	-	-	-
Selenium	1.6E+0	5.4E-1	3.1E-1	9.5E-1	3.1E-1	4.1E+0	-	2.5E+0	1.6E+1	2.0E+1	2.1E+0	3.1E+0	7.4E-1	1.7E+0	4.9E-1	3.0E+0	2.5E+0
Silver	1.7E-1	4.0E-2	4.8E-2	8.1E-2	4.0E-2	-	-	2.5E-1	-	1.2E-1	6.8E-1	4.8E-1	4.7E-2	7.0E-2	2.2E-1	-	2.5E-1
Strontium	7.1E+2	1.2E+3	1.6E+2	9.6E+2	1.5E+2	2.0E+4	-	2.1E+4	2.2E+4	1.1E+4	6.5E+3	7.8E+3	6.4E+3	6.3E+3	9.7E+2	1.5E+4	2.1E+4
Thallium	4.3E-1	2.8E-1	2.5E-1	1.3E+0	2.7E-1	9.3E-1	2.0E-1	-	-	-	4.3E-1	-	-	-	2.0E-1	-	-
Vanadium	3.2E-1	4.2E-1	4.3E-1	7.3E-1	9.6E-1	9.1E-1	4.3E-1	-	1.4E+0	-	-	6.8E-1	-	-	-	4.2E-1	-
Yttrium	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	-	NR	-	NR	NR
Zinc	3.2E+0	2.1E+0	1.2E+0	3.6E+0	2.6E+0	4.1E+0	-	4.8E+0	-	-	-	-	-	-	-	4.1E+0	4.8E+0
Total Metals[8]	7.3E+2	1.2E+3	1.6E+2	1.0E+3	1.6E+2	2.0E+4	7.0E+0	2.1E+4	2.2E+4	1.1E+4	6.5E+3	7.9E+3	6.5E+3	6.3E+3	9.8E+2	1.5E+4	2.1E+4
Lanthanide Metals																	
Cerium	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	-	NR	NR	NR
Lanthanum	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Neodymium	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Praseodymium	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	-	NR	NR	NR
Samarium	NR	NR	NR	NR	NR	NR	-	NR	-	NR	NR	NR	NR	NR	NR	NR	NR
Total Lanthanides[8]																	
Actinide Metals																	
Thorium	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	-	NR	NR	NR
Uranium	1.1E-1	2.9E-1	3.6E-1	1.8E-1	3.6E-1	7.1E+0	-	4.2E+0	2.8E+0	3.1E+0	1.6E+0	2.6E+0	2.2E+0	2.0E+0	2.8E-1	4.6E+0	4.2E+0
Radionuclides																	
Total Radionuclides	2.4E-2	2.8E-2	1.3E-2	9.0E-2	1.5E-2	P	P	P	P	P	P	P	P	P	P	P	P
GRAND SUM[8]	7.3E+2	1.2E+3	1.7E+2	1.0E+3	1.6E+2	2.0E+4	7.0E+0	2.1E+4	2.2E+4	1.1E+4	6.5E+3	7.9E+3	6.5E+3	6.3E+3	9.8E+2	1.5E+4	2.1E+4

1 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either younger alluvium (YA), bedrock (BD), or older alluvium (OA).
2 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or shonkenite (SK).
3 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or older alluvium (OA).
4 - HQ from exposure to background soil is the HQ from bedrock (BD).
5 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX), bedrock (BD), or older alluvium (OA).
6 - HQ from exposure to background soil is the HQ from older alluvium (OA).
7 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX) or older alluvium (OA).
8 - Summed HQs are provided only to facilitate spatial comparisons—summed HQ values are not intended to demonstrate the magnitude of total risk.

\- = Not a COPC
NA = Not available
NE = Not evaluated
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-16
Risk Estimates for Desert Plant Communities Exposed to Shallow Groundwater at Mine & Mill Site Areas of Concern

	HQs due to Bioaccumulation of COPCs				
		Baseline Scenario AOCs			Future Expansion Scenario AOC
COPC	Background GW	17 Spring	Jack Meyer's Pond Spring	Wheaton Wash / Roseberry Spring	Pit Lake
Metals					
Antimony	NR	-	-	-	-
Arsenic	-	7.1E+0	2.3E+1	-	-
Barium	NR	-	-	-	-
Beryllium	-	6.6E-4	7.1E-3	1.4E-3	-
Boron	2.8E-1	-	-	-	4.9E-1
Cadmium	-	7.1E-3	-	7.1E-2	-
Chromium	-	-	-	-	-
Cobalt	-	-	-	-	-
Copper	-	-	-	-	-
Lead	-	1.6E+1	-	1.8E-1	5.5E-1
Manganese	-	1.3E-1	3.8E-1	-	3.5E-2
Mercury	5.2E-1	-	2.8E-2	-	-
Molybdenum	-	-	3.6E-2	-	-
Nickel	-	1.4E-1	2.6E-1	-	-
Selenium	3.6E-3	2.0E-4	1.0E-2	-	1.3E-2
Silver	-	7.1E-3	3.5E-2	1.4E-1	-
Strontium	NR	-	-	-	-
Thallium	-	3.5E-2	1.8E-1	-	-
Vanadium	-	-	1.8E-1	-	-
Yttrium	NR	-	-	-	-
Zinc	-	-	-	-	1.8E-1
Total Metals [1]	8.0E-1	2.3E+1	2.4E+1	3.9E-1	1.3E+0
Lanthanide Metals					
Cerium	NR	NR	NR	NR	NR
Lanthanum	NR	NR	NR	NR	NR
Neodymium	NR	NR	NR	NR	NR
Praseodymium	NR	NR	NR	NR	NR
Samarium	NR	NR	NR	NR	NR
Total Lanthanides [1]					
Actinide Metals					
Thorium	NR	-	-	-	-
Uranium	8.8E-5	2.2E-3	2.4E-3	5.5E-4	5.5E-3
Radionuclides					
Total Radionuclides	1.0E-2	P	P	P	P
GRAND SUM [1]	8.1E-1	2.3E+1	2.4E+1	3.9E-1	1.3E+0

\- = No COPC
NA = Not available
NE = Not evaluated
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

1 - Summed HQs are provided only to facilitate spatial comparisons
—summed HQ values are not intended to demonstrate the magnitude of total risk.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-17
Risk Estimates for Soil Invertebrate Communities at Mine & Mill Site Areas of Concern

	HQs Due to Bioaccumulation of COPCs																
	Background															Future Expansion Scenario AOCs	
COPEC	Bedrock	Older Alluvium	Younger Alluvium	Shonkenite	Mixed	Overburden Stockpile[1]	North Tailings Pond (P-16)[2]	Windblown Tailings[3]	Seepage Collection Pond (P-23)[4]	Lanthanide Storage Ponds (P-25 and P-28)[3]	Sewage Treatment Pond (P-19)[5]	Administration Pond[6]	17 Spring[3]	Jack Meyer's Pond Spring[6]	Wheaton Wash / Roseberry Spring[7]	Pit Lake[2]	East Tailings Pond
Metals																	
Antimony	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Arsenic	4.1E-1	2.0E-1	1.9E-1	1.2E-1	4.9E-1	-	7.3E-1	-	-	8.3E-1	-	2.6E-1	-	4.6E-1	-	-	-
Barium	3.8E+0	3.9E+0	7.2E-1	6.7E+0	1.2E+0	9.2E+0	-	1.2E+1	9.1E+0	-	3.8E+0	1.4E+1	1.0E+1	-	4.7E+0	1.1E+1	1.2E+1
Beryllium	NR	NR	NR	NR	NR	NR	-	NR	-	NR	-	NR	NR	NR	-	NR	NR
Cadmium	2.6E-2	2.8E-2	1.3E-2	1.0E-2	1.3E-2	3.6E-2	3.7E-2	-	-	6.4E-2	7.0E-2	6.0E-2	-	3.7E-2	3.8E-2	-	-
Chromium	8.1E-2	8.4E-2	7.3E-2	1.3E+0	1.3E-1	3.6E-1	-	-	1.7E-1	1.3E-1	-	4.3E-1	-	-	-	-	-
Cobalt	6.1E-2	3.7E-2	3.2E-2	1.1E-1	1.1E-1	9.9E-2	-	-	-	-	-	-	-	-	-	-	-
Copper	1.2E-1	9.6E-2	8.1E-2	2.4E-1	2.0E-1	1.6E-1	1.8E-1	1.2E-1	-	-	-	-	-	-	-	1.5E-1	1.2E-1
Lead	3.7E-1	4.4E-1	8.2E-2	2.9E-1	2.4E-1	1.3E+1	-	6.7E+0	9.1E+0	1.5E+0	3.2E+0	1.4E+0	2.2E+0	3.9E+0	4.8E-1	6.4E+0	6.7E+0
Manganese	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	-	-	NR	NR	-	NR	NR
Mercury	1.0E-2	5.8E-3	4.0E-3	2.0E-2	6.4E-3	2.6E-2	2.3E-2	3.3E-2	2.5E-2	-	3.0E-1	-	3.0E-2	7.9E-2	9.0E-2	3.4E-2	3.3E-2
Molybdenum	2.3E-3	9.5E-4	1.1E-3	6.3E-4	7.2E-4	2.1E-2	-	1.0E-2	9.0E-2	4.5E-2	2.5E-2	1.6E-1	5.0E-3	1.1E-2	1.8E-3	1.6E-2	1.0E-2
Nickel	9.3E-2	7.4E-2	8.8E-2	1.4E+0	2.2E-1	3.0E-1	2.9E-1	-	-	-	-	3.5E-1	-	1.1E-1	-	-	-
Selenium	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Silver	NR	NR	NR	NR	NR	NR	-	NR	-	NR	NR	NR	NR	NR	NR	NR	NR
Strontium	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thallium	NR	NR	NR	NR	NR	NR	NR	-	-	-	NR	NR	-	NR	NR	NR	-
Vanadium	NR	NR	NR	NR	NR	NR	NR	-	NR	-	-	NR	-	-	-	NR	-
Yttrium	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	-	NR	-	NR	NR
Zinc	2.2E-1	1.5E-1	8.0E-2	2.5E-1	1.8E-1	2.9E-1	-	3.4E-1	-	-	-	-	-	-	-	2.8E-1	3.4E-1
Total Metals [8]	5.2E+0	5.1E+0	1.4E+0	1.0E+1	2.8E+0	2.3E+1	1.3E+0	1.9E+1	1.8E+1	2.6E+0	7.4E+0	1.7E+1	1.2E+1	4.6E+0	5.3E+0	1.8E+1	1.9E+1
Lanthanide Metals																	
Cerium	8.4E+1	5.8E+1	7.8E+0	2.0E+1	7.4E+0	4.0E+2	-	4.7E+2	4.1E+2	6.8E+3	1.9E+2	3.5E+2	1.0E+2	-	3.3E+1	5.3E+2	4.7E+2
Dysprosium	3.9E-1	1.4E-1	6.0E-2	2.6E-1	9.3E-2	1.3E+0	-	1.1E+0	4.5E+0	4.9E+1	1.8E+0	6.1E-1	2.5E-1	1.5E+0	1.4E-1	1.2E+0	1.1E+0
Erbium	1.3E-1	8.2E-2	2.8E-2	9.7E-2	4.7E-2	6.3E-1	-	7.0E-1	1.9E+0	1.7E+1	5.5E-1	3.5E-1	1.4E-1	9.2E-1	7.1E-2	7.2E-1	7.0E-1
Europium	7.3E-1	1.5E-1	2.5E-2	2.5E-1	3.2E-2	1.4E+0	-	1.3E+0	1.3E+0	1.2E+1	1.8E+0	8.4E-1	3.0E-1	1.6E+0	1.4E-1	1.6E+0	1.3E+0
Gadolinium	3.7E+0	1.6E+0	2.0E-1	1.0E+0	2.3E-1	1.1E+1	-	1.5E+1	1.3E+1	2.2E+2	1.1E+1	7.1E+0	-	1.3E+1	1.0E+0	1.4E+1	1.5E+1
Holmium	3.6E-2	1.5E-2	8.4E-3	3.2E-2	1.5E-2	1.1E-1	-	6.7E-2	5.2E-1	2.9E+0	1.5E-1	4.4E-2	-	1.3E-1	-	8.0E-2	6.7E-2
Lanthanum	4.0E+1	2.8E+1	4.9E+0	1.0E+1	3.9E+0	2.8E+2	-	3.3E+2	3.7E+2	7.6E+3	2.4E+2	1.8E+2	7.6E+1	3.9E+2	2.4E+1	3.8E+2	3.3E+2
Lutetium	6.6E-3	5.0E-3	2.6E-3	5.6E-3	4.1E-3	1.9E-2	-	2.2E-2	2.4E-2	1.7E-1	-	1.1E-2	-	4.0E-2	-	2.1E-2	2.2E-2
Neodymium	1.7E+1	1.1E+1	2.0E+0	7.8E+0	2.1E+0	1.2E+2	-	1.4E+2	1.8E+2	3.2E+3	8.0E+1	6.7E+1	2.5E+1	1.1E+2	1.2E+1	1.9E+2	1.4E+2
Praseodymium	5.6E+0	4.9E+0	6.6E-1	2.0E+0	5.9E-1	3.8E+1	-	4.1E+1	5.8E+1	1.1E+3	2.8E+1	2.6E+1	8.8E+0	4.5E+1	3.3E+0	4.7E+1	4.1E+1
Samarium	5.5E+0	8.5E-1	1.6E-1	1.0E+0	1.9E-1	8.5E+0	-	9.1E+0	-	7.5E+2	1.2E+1	4.8E+0	1.6E+0	9.4E+0	7.9E-1	9.7E+0	9.1E+0
Terbium	1.5E-1	6.6E-2	1.2E-2	7.8E-2	1.8E-2	5.0E-1	-	5.9E-1	9.8E-1	1.7E+1	1.9E+0	3.5E-1	1.3E-1	7.4E-1	-	6.0E-1	5.9E-1
Thulium	4.8E-3	4.1E-3	2.8E-3	7.1E-3	4.7E-3	2.0E-2	-	1.3E-2	1.8E-2	2.5E-1	-	5.6E-3	-	3.2E-2	-	1.4E-2	1.3E-2
Ytterbium	4.6E-2	2.7E-2	1.8E-2	4.3E-2	3.1E-2	1.3E-1	-	1.2E-1	1.2E-1	2.4E+0	-	4.6E-2	-	2.2E-1	-	1.2E-1	1.2E-1
Total Lanthanides [8]	1.6E+2	1.0E+2	1.6E+1	4.3E+1	1.5E+1	8.6E+2		1.0E+3	1.0E+3	2.0E+4	5.6E+2	6.3E+2	2.1E+2	5.8E+2	7.4E+1	1.2E+3	1.0E+3
														1.2E+1			
Actinide Metals																	
Thorium	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	-	NR	NR	NR
Uranium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radionuclides																	
Total Radionuclides	1.9E-1	1.9E-1	9.0E-2	6.6E-1	3.9E-1	1.6E+0	2.0E-1	8.2E-1	3.0E+0	1.9E+1	8.4E-1	6.1E-1	4.7E-1	9.6E-1	P	9.4E-1	8.2E-1
GRAND SUM[8]	1.6E+2	1.1E+2	1.7E+1	5.4E+1	1.8E+1	8.8E+2	1.5E+0	1.0E+3	1.1E+3	2.0E+4	5.7E+2	6.5E+2	2.2E+2	5.8E+2	8.0E+1	1.2E+3	1.0E+3

1 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either younger alluvium (YA), bedrock (BD), or older alluvium (OA).
2 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or shonkenite (SK).
3 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or older alluvium (OA).
4 - HQ from exposure to background soil is the HQ from bedrock (BD).
5 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX), bedrock (BD), or older alluvium (OA).
6 - HQ from exposure to background soil is the HQ from older alluvium (OA).
7 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX) or older alluvium (OA).
8 - Summed HQs are provided only to facilitate spatial comparisons—summed HQ values are not intended to demonstrate the magnitude of total risk.

\- = Not a COPC
NA = Not available
NE = Not evaluated
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-18
Risk Estimates for the Desert Tortoise at Mine & Mill Site Areas of Concern

	HQs Due to Ingestion of Food, Soils, Fugitive Dust, and Surface Water																
	Background					Baseline Scenario AOCs										Future Expansion Scenario AOCs	
COPEC	Bedrock	Older Alluvium	Younger Alluvium	Shonkenite	Mixed	Overburden Stockpile[1]	North Tailings Pond (P-16)[2]	Windblown Tailings[3]	Seepage Collection Pond (P-23)[4]	Lanthanide Storage Ponds (P-25 and P-28)[3]	Sewage Treatment Pond (P-19)[5]	Administration Pond[6]	17 Spring[3]	Jack Meyer's Pond Spring[6]	Wheaton Wash / Roseberry Spring[7]	Pit Lake[2]	East Tailings Pond
Metals																	
Antimony	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Arsenic	1.6E-2	8.9E-3	8.5E-3	5.9E-3	1.9E-2	-	2.8E-2	-	1.2E-2	3.4E-2	-	1.1E-2	8.0E-3	1.8E-2	-	-	-
Barium	1.5E-1	1.5E-1	2.8E-2	2.6E-1	4.7E-2	6.1E-1	1.3E-1	4.7E-1	3.6E-1	2.0E-1	1.5E-1	5.5E-1	4.0E-1	2.8E-1	1.9E-1	4.5E-1	4.7E-1
Beryllium	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium	6.4E-3	6.7E-3	4.3E-3	3.7E-3	4.2E-3	1.3E-2	7.9E-3	-	7.6E-3	1.2E-2	1.1E-2	1.0E-2	3.3E-3	7.8E-3	8.0E-3	-	-
Chromium	1.1E-1	1.1E-1	9.7E-2	1.7E+0	1.7E-1	8.2E-1	2.0E-1	-	2.2E-1	1.7E-1	2.3E-1	5.7E-1	7.7E-2	1.3E-1	-	-	-
Cobalt	NR	NR	NR	NR	NR	NR	NR	-	-	NR	-	-	-	-	-	-	-
Copper	9.3E-2	8.2E-2	7.5E-2	1.4E-1	1.2E-1	1.9E-1	1.2E-1	9.4E-2	1.1E-1	1.3E-1	1.1E-1	1.0E-1	6.5E-2	9.9E-2	-	1.0E-1	9.4E-2
Lead	9.8E-2	1.1E-1	2.7E-2	7.9E-2	6.7E-2	4.5E+0	1.3E-1	1.4E+0	1.9E+0	3.6E-1	7.1E-1	3.2E-1	5.0E-1	8.6E-1	1.2E-1	1.4E+0	1.4E+0
Manganese	3.9E-3	1.9E-3	1.4E-3	2.2E-3	3.1E-3	1.9E-2	3.0E-3	1.9E-2	1.7E-2	3.4E-3	8.9E-3	2.1E-3	3.1E-3	7.9E-2	-	1.8E-2	1.9E-2
Mercury	7.0E-3	5.0E-3	4.0E-3	1.0E-2	5.2E-3	2.1E-2	1.1E-2	1.4E-2	1.2E-2	-	5.7E-2	-	1.3E-2	2.4E-2	2.6E-2	1.4E-2	1.4E-2
Molybdenum	1.7E-3	6.8E-4	8.0E-4	4.5E-4	5.2E-4	2.6E-2	1.3E-2	7.1E-3	7.0E-2	3.2E-2	1.8E-2	1.1E-1	3.6E-3	8.2E-3	1.3E-3	1.1E-2	7.1E-3
Nickel	1.4E-3	1.2E-3	1.4E-3	1.7E-2	3.1E-3	7.1E-3	4.2E-3	-	-	3.5E-3	-	4.8E-3	7.6E-4	1.8E-3	-	-	-
Selenium	7.7E-2	2.4E-2	1.3E-2	4.5E-2	1.3E-2	3.7E-1	2.0E-2	1.3E-1	9.7E-1	1.3E+0	1.1E-1	1.6E-1	3.4E-2	8.6E-2	2.2E-2	1.6E-1	1.3E-1
Silver	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR
Strontium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thallium	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	-	NR	-
Vanadium	8.9E-2	1.2E-1	1.2E-1	2.1E-1	2.7E-1	4.3E-1	1.3E-1	-	4.2E-1	2.2E-1	-	1.9E-1	-	1.2E-1	-	1.2E-1	-
Yttrium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR
Zinc	3.0E-1	2.3E-1	1.6E-1	3.2E-1	2.6E-1	5.9E-1	-	3.8E-1	-	7.1E-1	-	-	-	-	-	3.4E-1	3.8E-1
Total Metals[8]	9.5E-1	8.6E-1	5.4E-1	2.8E+0	9.9E-1	7.6E+0	8.0E-1	2.6E+0	4.1E+0	3.2E+0	1.4E+0	2.0E+0	1.1E+0	1.7E+0	3.6E-1	2.6E+0	2.6E+0
Lanthanide Metals																	
Cerium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR
Lanthanum	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Neodymium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Praseodymium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Samarium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Total Lanthanides[8]																	
Actinide Metals																	
Thorium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium	5.1E-4	4.0E-4	2.6E-4	1.5E-3	1.5E-4	1.7E-2	1.5E-3	5.9E-3	3.9E-3	4.6E-3	2.2E-3	3.6E-3	3.3E-3	2.9E-3	4.4E-4	6.9E-3	5.9E-3
Radionuclides																	
Total Radionuclides	8.1E-2	9.3E-2	4.2E-2	3.1E-1	6.3E-2	6.7E-1	1.0E-1	3.5E-1	1.3E+0	7.5E+0	3.9E-1	2.7E-1	2.1E-1	3.9E-1	P	4.1E-1	3.5E-1
GRAND SUM[8]	1.0E+0	9.5E-1	5.8E-1	3.1E+0	1.0E+0	8.3E+0	9.0E-1	2.9E+0	5.5E+0	1.1E+1	1.8E+0	2.3E+0	1.3E+0	2.1E+0	3.7E-1	3.0E+0	2.9E+0

Site presence index for desert tortoise at all AOCs: site area / foraging area = 0.59 (Drinking frequency index = 1). For radionuclides, site presence index and drinking frequency index = 0.59.

1 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either younger alluvium (YA), bedrock (BD), or older alluvium (OA).
2 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or shonkenite (SK).
3 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or older alluvium (OA).
4 - HQ from exposure to background soil is the HQ from bedrock (BD).
5 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX), bedrock (BD), or older alluvium (OA).
6 - HQ from exposure to background soil is the HQ from older alluvium (OA).
7 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX) or older alluvium (OA).
8 - Summed HQs are provided only to facilitate spatial comparisons—summed HQ values are not intended to demonstrate the magnitude of total risk.

\- = Not a COPC
NA = Not available
NE = Not evaluated
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-19
Risk Estimates for the Northern Shoveler at Mine & Mill Site Areas of Concern

	HQs due to Ingestion of Food, Sediment, and Surface Water						
		Baseline Scenario AOCs			Future Expansion Scenario AOCs		
COPC	Background Sediment	North Tailings Pond (P-16)	Lanthanide Storage Ponds (P-25 and P-28)	Administration Pond	Pit Lake	Onsite Evaporation Ponds	East Tailings Pond
Metals							
Antimony	NR	NR	NR	NR	NR	NR	NR
Arsenic	8.7E-3	2.3E-3	1.0E-1	3.3E-2	-	3.9E-3	2.3E-3
Barium	1.3E-1	3.7E+0	1.5E+0	4.3E+0	3.5E+0	1.3E-2	3.7E+0
Beryllium	NR	NR	NR	NR	NR	NR	NR
Boron	NR	NR	NR	NR	NR	NR	NR
Cadmium	2.0E-2	1.0E-4	4.8E-2	4.4E-2	-	1.8E-3	1.0E-4
Chromium	3.6E-1	6.6E-3	5.3E-1	6.2E-1	-	1.1E-2	6.6E-3
Cobalt	NR	NR	NR	-	NR	NR	NR
Copper	5.6E-1	6.9E-1	8.7E-1	-	5.8E-1	2.7E-3	6.9E-1
Lead	1.6E-2	2.2E+0	5.4E-1	4.7E-1	2.5E+1	3.1E-2	2.2E+0
Manganese	2.3E-2	2.1E-1	3.7E-2	4.1E-6	2.0E-1	1.6E-3	2.1E-1
Mercury	6.2E-3	1.8E-2	-	1.1E-1	4.0E-2	1.3E-4	1.8E-2
Molybdenum	1.9E-3	5.2E-2	1.8E-1	6.5E-1	6.5E-2	8.2E-4	5.2E-2
Nickel	1.2E-2	2.2E-4	7.5E-3	8.3E-3	-	2.3E-4	2.2E-4
Selenium	3.1E-2	3.9E-1	3.2E+0	4.8E-1	4.7E-1	6.2E-2	3.9E-1
Silver	NR	NR	NR	NR	NR	NR	NR
Strontium	NR	NR	NR	NR	NR	NR	NR
Thallium	NR	NR	NR	NR	NR	NR	NR
Vanadium	2.5E+0	2.3E-2	4.1E+0	-	2.2E+0	4.5E-2	2.3E-2
Yttrium	NR	NR	NR	NR	NR	NR	NR
Zinc	9.7E-1	1.4E+0	1.8E+0	1.5E+0	1.2E+0	3.8E-1	1.4E+0
Total Metals [2]	4.7E+0	8.6E+0	1.3E+1	8.2E+0	3.3E+1	5.6E-1	8.6E+0
Lanthanide Metals							
Cerium	NR	NR	NR	NR	NR	NR	NR
Lanthanum	NR	NR	NR	NR	NR	NR	NR
Neodymium	NR	NR	NR	NR	NR	NR	NR
Praseodymium	NR	NR	NR	NR	NR	NR	NR
Samarium	NR	NR	NR	NR	NR	NR	NR
Total Lanthanides [2]							
Actinide Metals							
Thorium	NR	NR	NR	NR	NR	NR	NR
Uranium	3.3E-3	1.1E-1	8.0E-2	6.5E-2	1.2E-1	-	1.1E-1
Radionuclides							
Total Radionuclides	3.4E-1	4.0E-1	3.0E+1	1.1E+0	1.7E+0	P	4.0E-1
GRAND SUM [1]	5.0E+0	9.1E+0	4.3E+1	9.4E+0	3.5E+1	5.6E-1	9.1E+0

Site presence index for northern shoveler at all AOCs = 1

- = No COPC
NR = No RTV
NE = Site passed the DOE BCG graded approach—not evaluated since the species/

1 - Summed HQs are provided only to facilitate spatial comparisons
—summed HQ values are not intended to demonstrate the magnitude of total risk.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

- = No COPC
NA = Not available
NE = Not evaluated
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-20
Risk Estimates for the Gambel's Quail at Mine & Mill Site Areas of Concern

	HQs Due to Ingestion of Food, Soils, Fugitive Dust, and Surface Water																	
	Background					Baseline Scenario AOCs										Future Expansion Scenario AOCs		
COPEC	Bedrock	Older Alluvium	Younger Alluvium	Shonkenite	Mixed	Overburden Stockpile[1]	North Tailings Pond (P-16)[2]	Windblown Tailings[3]	Seepage Collection Pond (P-23)[4]	Lanthanide Storage Ponds (P-25 and P-28)[3]	Sewage Treatment Pond (P-19)[5]	Administration Pond[6]	17 Spring[3]	Jack Meyer's Pond Spring[6]	Wheaton Wash / Roseberry Spring[7]	Pit Lake[2]	Future Onsite Evaporation Ponds[8]	East Tailings Pond
Metals																		
Antimony	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Arsenic	6.3E-2	3.4E-2	3.2E-2	2.2E-2	7.3E-2	-	1.1E-1	-	4.5E-2	1.2E-1	-	4.1E-2	3.0E-2	6.9E-2	-	-	4.7E-3	-
Barium	5.6E-1	5.8E-1	1.1E-1	9.9E-1	1.8E-1	1.4E+0	5.0E-1	1.8E+0	1.3E+0	7.3E-1	5.7E-1	2.1E+0	1.5E+0	1.1E+0	7.0E-1	1.7E+0	1.5E-2	1.8E+0
Beryllium	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	NR
Boron	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium	2.4E-2	2.5E-2	1.6E-2	1.4E-2	1.6E-2	2.9E-2	3.0E-2	-	2.8E-2	4.2E-2	4.3E-2	3.9E-2	1.2E-2	2.9E-2	3.0E-2	-	2.2E-3	-
Chromium	4.1E-1	4.2E-1	3.7E-1	6.5E+0	6.4E-1	1.8E+0	7.5E-1	-	8.4E-1	6.5E-1	8.8E-1	2.2E+0	2.9E-1	4.9E-1	-	-	1.3E-2	-
Cobalt	NR	NR	NR	NR	NR	NR	NR	-	-	NR	-	-	-	-	-	-	NR	-
Copper	3.5E-1	3.1E-1	2.8E-1	5.2E-1	4.6E-1	4.2E-1	4.4E-1	3.5E-1	4.0E-1	5.1E-1	4.1E-1	3.8E-1	2.5E-1	3.7E-1	-	3.9E-1	3.2E-3	3.5E-1
Lead	3.7E-1	4.3E-1	1.0E-1	3.0E-1	2.5E-1	1.0E+1	3.4E-1	5.5E+0	7.4E+0	1.4E+0	2.7E+0	1.2E+0	1.9E+0	3.3E+0	4.7E-1	5.3E+0	3.7E-2	5.5E+0
Manganese	1.5E-2	7.4E-3	5.2E-3	8.5E-3	1.2E-2	4.2E-2	9.6E-3	7.1E-2	6.3E-2	1.3E-2	3.4E-2	8.1E-3	1.2E-2	3.0E-1	-	6.8E-2	2.0E-3	7.1E-2
Mercury	2.6E-2	1.9E-2	1.5E-2	3.8E-2	2.0E-2	4.6E-2	4.2E-2	5.2E-2	4.3E-2	-	2.1E-1	-	4.9E-2	8.9E-2	9.7E-2	5.3E-2	1.5E-4	5.2E-2
Molybdenum	6.2E-3	2.6E-3	3.0E-3	1.7E-3	1.9E-3	5.8E-2	3.5E-2	2.7E-2	2.5E-1	1.2E-1	6.7E-2	4.3E-1	1.3E-2	3.1E-2	4.7E-3	4.3E-2	9.8E-4	2.7E-2
Nickel	5.4E-3	4.4E-3	5.1E-3	6.6E-2	1.2E-2	1.6E-2	1.6E-2	-	-	1.3E-2	-	1.8E-2	2.8E-3	6.5E-3	-	-	2.7E-4	-
Selenium	2.9E-1	9.0E-2	5.0E-2	1.7E-1	5.0E-2	8.2E-1	7.5E-2	4.8E-1	3.6E+0	4.7E+0	4.0E-1	6.1E-1	1.3E-1	3.2E-1	8.2E-2	5.9E-1	7.3E-2	4.8E-1
Silver	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR
Strontium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thallium	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	-	NR	NR	-
Vanadium	3.4E-1	4.5E-1	4.6E-1	7.8E-1	1.0E+0	9.7E-1	4.8E-1	-	1.5E+0	8.3E-1	-	7.3E-1	-	-	-	4.5E-1	5.3E-2	-
Yttrium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR
Zinc	1.1E+0	8.7E-1	5.9E-1	1.2E+0	9.8E-1	1.3E+0	-	1.4E+0	-	2.6E+0	-	-	-	-	-	1.3E+0	4.5E-1	1.4E+0
Total Metals[9]	3.6E+0	3.3E+0	2.0E+0	1.1E+1	3.7E+0	1.7E+1	2.8E+0	9.7E+0	1.6E+1	1.2E+1	5.3E+0	7.7E+0	4.2E+0	6.1E+0	1.4E+0	9.9E+0	6.6E-1	9.7E+0
Lanthanide Metals																		
Cerium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR
Lanthanum	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Neodymium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Praseodymium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Samarium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Total Lanthanides[9]																		
Actinide Metals																		
Thorium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium	1.9E-3	1.5E-3	9.8E-4	5.9E-3	5.6E-4	3.8E-2	4.0E-3	2.3E-2	1.5E-2	1.7E-2	8.4E-3	1.4E-2	1.2E-2	1.1E-2	1.5E-3	2.5E-2	-	2.3E-2
Radionuclides																		
Total Radionuclides	1.1E-1	1.3E-1	5.6E-2	4.1E-1	5.7E-2	8.8E-1	4.1E-1	4.6E-1	1.7E+0	9.7E+0	5.3E-1	3.6E-1	2.8E-1	5.1E-1	P	6.0E-1	P	4.6E-1
GRAND SUM[9]	3.6E+0	3.3E+0	2.0E+0	1.1E+1	3.7E+0	1.7E+1	2.8E+0	9.8E+0	1.6E+1	1.2E+1	5.3E+0	7.7E+0	4.2E+0	6.1E+0	1.4E+0	9.9E+0	6.6E-1	9.8E+0

Site presence index for Gambel's quail at all AOCs = 1

1 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either younger alluvium (YA), bedrock (BD), or older alluvium (OA).
2 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or shonkenite (SK).
3 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or older alluvium (OA).
4 - HQ from exposure to background soil is the HQ from bedrock (BD).
5 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX), bedrock (BD), or older alluvium (OA).
6 - HQ from exposure to background soil is the HQ from older alluvium (OA).
7 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX) or older alluvium (OA).
8 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or younger alluvium (YA).
9 - Summed HQs are provided only to facilitate spatial comparisons—summed HQ values are not intended to demonstrate the magnitude of total risk.

\- = Not a COPC
NA = Not available
NE = Not evaluated
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-21
Risk Estimates for the Cactus Wren at Mine & Mill Site Areas of Concern

	HQs Due to Ingestion of Food, Soils, Fugitive Dust, and Surface Water																	
	Background																	
COPEC	Bedrock	Older Alluvium	Younger Alluvium	Shonkenite	Mixed	Overburden Stockpile[1]	North Tailings Pond (P-16)[2]	Windblown Tailings[3]	Seepage Collection Pond (P-23)[4]	Lanthanide Storage Ponds (P-25 and P-28)[3]	Sewage Treatment Pond (P-19)[5]	Administration Pond[6]	17 Spring[3]	Jack Meyer's Pond Spring[6]	Wheaton Wash / Roseberry Spring[7]	Pit Lake[2]	Future Onsite Evaporation Ponds[8]	East Tailings Pond
Metals																		
Antimony	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Arsenic	2.5E-1	1.4E-1	1.3E-1	9.1E-2	2.9E-1	-	4.2E-1	-	1.8E-1	4.9E-1	-	1.7E-1	1.2E-1	2.7E-1	-	-	2.2E-2	-
Barium	1.2E+0	1.2E+0	2.2E-1	2.0E+0	3.6E-1	2.8E+0	1.0E+0	3.6E+0	2.8E+0	1.6E+0	1.2E+0	4.3E+0	3.1E+0	2.2E+0	1.4E+0	3.5E+0	7.1E-2	3.6E+0
Beryllium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium	6.0E-1	6.4E-1	3.5E-1	2.8E-1	3.4E-1	7.7E-1	7.9E-1	-	7.6E-1	1.2E+0	1.3E+0	1.2E+0	2.4E-1	7.9E-1	8.0E-1	-	1.0E-2	-
Chromium	8.6E+0	8.8E+0	7.7E+0	1.3E+2	1.3E+1	3.8E+1	1.6E+1	-	1.8E+1	1.4E+1	1.8E+1	4.5E+1	6.1E+0	1.0E+1	-	-	6.3E-2	-
Cobalt	NR	NR	NR	NR	NR	NR	NR	-	-	NR	-	-	-	-	-	-	NR	-
Copper	1.5E+0	1.4E+0	1.3E+0	2.0E+0	1.9E+0	1.7E+0	1.8E+0	1.5E+0	1.7E+0	2.0E+0	1.7E+0	1.6E+0	1.2E+0	1.6E+0	-	1.7E+0	1.5E-2	1.5E+0
Lead	3.2E+0	3.7E+0	8.8E-1	2.6E+0	2.2E+0	6.7E+1	2.8E+0	3.9E+1	5.0E+1	1.1E+1	2.0E+1	9.6E+0	1.5E+1	2.4E+1	3.9E+0	3.7E+1	1.7E-1	3.9E+1
Manganese	3.4E-2	1.8E-2	1.4E-2	2.1E-2	2.8E-2	8.8E-2	2.8E-2	1.4E-1	1.3E-1	3.0E-2	7.2E-2	2.0E-2	2.8E-2	5.5E-1	-	1.4E-1	9.2E-3	1.4E-1
Mercury	3.1E-1	2.5E-1	2.2E-1	3.9E-1	2.6E-1	4.3E-1	4.1E-1	4.7E-1	4.2E-1	-	1.1E+0	-	4.5E-1	6.5E-1	6.8E-1	4.7E-1	7.1E-4	4.7E-1
Molybdenum	5.1E-2	2.1E-2	2.5E-2	1.4E-2	1.6E-2	4.7E-1	2.8E-1	2.2E-1	2.0E+0	9.9E-1	5.5E-1	3.5E+0	1.1E-1	2.5E-1	3.8E-2	3.5E-1	4.6E-3	2.2E-1
Nickel	1.1E-1	8.4E-2	1.0E-1	1.5E+0	2.5E-1	3.4E-1	3.3E-1	-	-	2.7E-1	-	3.9E-1	5.1E-2	1.3E-1	-	-	1.3E-3	-
Selenium	1.2E+0	5.1E-1	3.4E-1	7.9E-1	3.4E-1	2.4E+0	4.5E-1	1.7E+0	6.9E+0	8.5E+0	1.5E+0	1.9E+0	6.5E-1	1.2E+0	4.8E-1	1.9E+0	3.5E-1	1.7E+0
Silver	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR
Strontium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thallium	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	-	NR	NR	-
Vanadium	1.2E+0	1.7E+0	1.7E+0	2.9E+0	3.8E+0	3.6E+0	1.8E+0	-	5.7E+0	3.1E+0	-	2.7E+0	-	1.6E+0	-	1.7E+0	2.5E-1	-
Yttrium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	-	NR
Zinc	1.5E+1	1.3E+1	1.0E+1	1.5E+1	1.4E+1	1.6E+1	-	1.7E+1	-	2.4E+1	-	-	-	-	-	1.6E+1	2.1E+0	1.7E+1
Total Metals[9]	3.3E+1	3.1E+1	2.3E+1	1.6E+2	3.7E+1	1.3E+2	2.6E+1	6.3E+1	8.9E+1	6.6E+1	4.6E+1	7.0E+1	2.7E+1	4.4E+1	7.4E+0	6.3E+1	3.1E+0	6.3E+1
Lanthanide Metals																		
Cerium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NA	NR
Lanthanum	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NA	NR
Lutetium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NA	NR
Neodymium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NA	NR
Praseodymium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NA	NR
Samarium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NA	NR
Total Lanthanides[9]																	NR	
Actinide Metals																		
Thorium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium	6.4E-3	5.1E-3	3.3E-3	2.0E-2	1.9E-3	1.3E-1	1.7E-2	7.5E-2	5.0E-2	5.8E-2	2.8E-2	4.6E-2	4.1E-2	3.7E-2	5.4E-3	8.7E-2	-	7.5E-2
Radionuclides																		
Total Radionuclides	1.1E+0	1.3E+0	5.7E-1	4.2E+0	7.0E-1	9.0E+0	1.2E+0	3.7E+0	1.6E+1	7.6E+1	5.4E+0	2.8E+0	2.1E+0	4.0E+0	P	6.0E-1	P	3.7E+0
GRAND SUM[9]	3.4E+1	3.2E+1	2.4E+1	1.7E+2	3.8E+1	1.4E+2	2.7E+1	6.7E+1	1.0E+2	1.4E+2	5.1E+1	7.3E+1	2.9E+1	4.8E+1	7.4E+0	6.3E+1	3.1E+0	6.7E+1

Site presence index for cactus wren at all AOCs = 1

1 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either younger alluvium (YA), bedrock (BD), or older alluvium (OA).
2 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or shonkenite (SK).
3 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or older alluvium (OA).
4 - HQ from exposure to background soil is the HQ from bedrock (BD).
5 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX), bedrock (BD), or older alluvium (OA).
6 - HQ from exposure to background soil is the HQ from older alluvium (OA).
7 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX) or older alluvium (OA).
8 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or younger alluvium (YA).
9 - Summed HQs are provided only to facilitate spatial comparisons—summed HQ values are not intended to demonstrate the magnitude of total risk.

\- = Not a COPC
NA = Not available
NE = Not evaluated
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-22
Risk Estimates for the American Kestrel at Mine & Mill Site Areas of Concern

HQs Due to Ingestion of Food (insectivorous mammals), Soils, and Surface Water

COPEC	Background: Bedrock	Background: Older Alluvium	Background: Younger Alluvium	Background: Shonkenite	Background: Mixed	Baseline Scenario AOCs: Overburden Stockpile[1]	Baseline Scenario AOCs: North Tailings Pond (P-16)[2]	Baseline Scenario AOCs: Windblown Tailings[3]	Baseline Scenario AOCs: Seepage Collection Pond (P-23)[4]	Baseline Scenario AOCs: Lanthanide Storage Ponds (P-25 and P-28)[3]	Baseline Scenario AOCs: Sewage Treatment Pond (P-19)[5]	Baseline Scenario AOCs: Administration Pond[6]	Baseline Scenario AOCs: 17 Spring[3]	Baseline Scenario AOCs: Jack Meyer's Pond Spring[6]	Baseline Scenario AOCs: Wheaton Wash / Roseberry Spring[7]	Future Expansion Scenario AOCs: Pit Lake[2]	Future Expansion Scenario AOCs: Future Onsite Evaporation Ponds[8]	Future Expansion Scenario AOCs: Windblown Tailings[3]
Metals																		
Antimony	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR
Arsenic	6.6E-3	3.9E-3	3.7E-3	2.9E-3	7.6E-3	-	1.7E-2	-	5.2E-3	2.9E-2	-	4.2E-3	3.2E-3	8.0E-3	-	-	8.1E-3	-
Barium	1.0E-1	1.0E-1	7.9E-2	1.2E-1	8.3E-2	4.2E-1	9.1E-2	3.2E-1	2.4E-1	2.0E-1	1.0E-1	3.0E-1	2.8E-1	1.9E-1	1.3E-1	3.0E-1	2.6E-2	3.2E-1
Beryllium	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	-	NR
Cadmium	3.0E-2	3.0E-2	3.0E-2	3.0E-2	3.0E-2	6.8E-2	4.2E-2	-	4.0E-2	7.6E-2	7.7E-2	1.0E-2	9.8E-3	4.1E-2	4.3E-2	-	3.8E-3	-
Chromium	2.2E-1	2.2E-1	2.1E-1	7.3E-1	2.4E-1	1.2E+0	3.6E-1	-	3.9E-1	3.2E-1	3.9E-1	3.3E-1	1.7E-1	2.5E-1	-	-	2.3E-2	-
Cobalt	NR	NR	NR	NR	NR	NR	NR	-	-	NR	-	-	-	-	-	-	-	-
Copper	3.4E-1	3.4E-1	3.4E-1	3.6E-1	3.5E-1	6.2E-1	3.8E-1	3.5E-1	3.6E-1	3.9E-1	3.6E-1	3.1E-1	3.0E-1	3.5E-1	-	3.6E-1	5.5E-3	3.5E-1
Lead	2.7E-1	2.8E-1	2.5E-1	2.7E-1	2.6E-1	4.1E+0	5.5E-1	1.6E+0	2.0E+0	6.2E-1	9.7E-1	6.9E-1	7.7E-1	1.1E+0	3.1E-1	1.5E+0	6.4E-2	1.6E+0
Manganese	1.0E-3	5.0E-4	3.5E-4	5.7E-4	7.8E-4	4.8E-3	3.9E-3	4.8E-3	4.9E-3	1.2E-3	2.3E-3	5.5E-4	8.5E-4	2.0E-2	-	4.6E-3	3.4E-3	4.8E-3
Mercury	1.0E-3	9.1E-4	8.6E-4	1.3E-3	9.3E-4	4.5E-3	2.3E-3	3.3E-3	2.4E-3	-	2.9E-2	-	2.9E-3	7.9E-3	8.9E-3	3.4E-3	2.6E-4	3.3E-3
Molybdenum	2.2E-4	8.9E-5	1.1E-4	5.9E-5	6.8E-5	3.4E-3	2.6E-2	9.4E-4	3.5E-2	4.9E-3	2.3E-3	1.9E-2	4.7E-4	1.4E-3	1.6E-4	1.5E-3	1.7E-3	9.4E-4
Nickel	3.8E-3	3.7E-3	3.8E-3	9.6E-3	4.4E-3	1.2E-2	7.6E-3	-	-	6.6E-3	-	4.0E-3	2.8E-3	4.5E-3	-	-	4.8E-4	-
Selenium	1.4E-1	1.4E-1	1.4E-1	1.4E-1	1.4E-1	3.6E-1	8.9E-2	1.7E-1	3.9E-1	5.2E-1	1.6E-1	1.1E-1	1.1E-1	1.5E-1	9.0E-2	1.9E-1	1.3E-1	1.7E-1
Silver	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	-	NR
Strontium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR
Thallium	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	NR	NR	NR	-	NR	-	-
Vanadium	3.9E-2	5.2E-2	5.2E-2	8.9E-2	1.2E-1	1.9E-1	1.0E-1	-	3.3E-1	1.0E-1	-	-	-	5.5E-2	-	5.2E-2	9.3E-2	-
Yttrium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NR	-	NR
Zinc	9.0E-1	8.9E-1	8.9E-1	9.0E-1	9.0E-1	1.6E+0	-	9.4E-1	-	1.2E+0	-	-	-	-	-	9.2E-1	7.9E-1	9.4E-1
Total Metals[9]	2.1E+0	2.1E+0	2.0E+0	2.7E+0	2.1E+0	8.6E+0	1.7E+0	3.4E+0	3.8E+0	3.5E+0	2.1E+0	1.8E+0	1.6E+0	2.2E+0	5.8E-1	3.4E+0	1.2E+0	3.4E+0
Lanthanide Metals																		
Cerium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	NR	NR	NA	NR
Lanthanum	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NA	NR
Neodymium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NA	NR
Praseodymium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NA	NR
Samarium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NA	NR
Total Lanthanides[9]																	?	
Actinide Metals																		
Thorium	NR	NR	NR	NR	NR	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	2.1E-4	1.7E-4	1.1E-4	6.5E-4	6.2E-5	7.0E-3	3.8E-3	2.5E-3	1.9E-3	3.2E-3	9.8E-4	1.7E-3	2.3E-3	2.3E-3	4.1E-4	5.2E-3	-	2.5E-3
Radionuclides																		
Total Radionuclides	1.4E+0	1.7E+0	7.0E-1	5.5E+0	4.8E-1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
GRAND SUM[9]	3.4E+0	3.7E+0	2.7E+0	8.1E+0	2.6E+0	8.6E+0	1.7E+0	3.4E+0	3.8E+0	3.5E+0	2.1E+0	1.8E+0	1.6E+0	2.2E+0	5.8E-1	3.4E+0	1.2E+0	3.4E+0

Site presence index for American kestrel at all AOCs: site area / foraging area = 0.59 (Drinking frequency index = 1). For radionuclides, site presence index and drinking frequency index = 0.59.

1 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either younger alluvium (YA), bedrock (BD), or older alluvium (OA).
2 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or shonkenite (SK).
3 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or older alluvium (OA).
4 - HQ from exposure to background soil is the HQ from bedrock (BD).
5 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX), bedrock (BD), or older alluvium (OA).
6 - HQ from exposure to background soil is the HQ from older alluvium (OA).
7 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX) or older alluvium (OA).
8 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or younger alluvium (YA).
9 - Summed HQs are provided only to facilitate spatial comparisons—summed HQ values are not intended to demonstrate the magnitude of total risk.

\- = Not a COPC
NA = Not available
NE = Not evaluated
NR = No RTV

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-23
Risk Estimates for the Desert Kangaroo Rat at Mine & Mill Site Areas of Concern

	HQs Due to Ingestion of Food, Soils, Fugitive Dust, and Surface Water																	
	Background																	
COPEC	Bedrock	Older Alluvium	Younger Alluvium	Shonkenite	Mixed	Overburden Stockpile[1]	North Tailings Pond (P-16)[2]	Windblown Tailings[3]	Seepage Collection Pond (P-23)[4]	Lanthanide Storage Ponds (P-25 and P-28)[3]	Sewage Treatment Pond (P-19)[5]	Administration Pond[6]	17 Spring[3]	Jack Meyer's Pond Spring[6]	Wheaton Wash / Roseberry Spring[7]	Pit Lake[2]	Future Onsite Evaporation Ponds[8]	East Tailings Pond
Metals																		
Antimony	2.6E-2	5.6E-3	2.1E-2	9.3E-3	0.0E+0	7.3E-1	8.0E-2	3.5E-1	1.5E-1	7.7E-1	7.9E-2	1.0E-1	8.5E-2	3.9E-1	3.9E-2	3.8E-1	2.7E-1	3.5E-1
Arsenic	1.2E-1	7.5E-2	7.2E-2	5.4E-2	1.4E-1	-	2.2E-1	-	9.9E-2	3.1E-1	-	9.0E-2	7.0E-2	1.4E-1	-	-	5.4E-2	-
Barium	5.9E+0	6.1E+0	1.1E+0	1.0E+1	1.8E+0	1.4E+1	5.3E+0	1.9E+1	1.4E+1	8.6E+0	5.9E+0	2.2E+1	1.6E+1	1.1E+1	7.3E+0	1.8E+1	4.7E-1	1.9E+1
Beryllium	2.6E-2	1.1E-2	9.1E-3	1.2E-1	1.6E-2	1.8E-1	3.1E-2	2.6E-2	-	3.6E-2	2.1E-2	2.8E-2	1.2E-2	2.6E-2	1.2E-2	6.2E-2	8.7E-3	2.6E-2
Cadmium	2.2E-2	2.3E-2	1.5E-2	1.3E-2	1.4E-2	2.6E-2	2.7E-2	-	2.6E-2	4.3E-2	3.9E-2	3.6E-2	1.1E-2	2.7E-2	2.8E-2	-	5.5E-3	-
Chromium	6.7E-2	6.9E-2	6.0E-2	1.1E+0	1.0E-1	3.0E-1	1.3E-1	-	1.4E-1	1.1E-1	1.4E-1	3.5E-1	4.7E-2	8.0E-2	-	-	7.0E-3	-
Cobalt	8.0E-2	4.9E-2	4.2E-2	1.5E-1	1.4E-1	1.3E-1	9.4E-2	-	-	1.7E-1	-	-	-	-	-	-	9.4E-3	-
Copper	4.9E-2	4.3E-2	3.9E-2	7.1E-2	6.3E-2	5.7E-2	6.2E-2	4.9E-2	5.5E-2	6.9E-2	5.6E-2	5.2E-2	3.5E-2	5.1E-2	-	5.4E-2	1.3E-3	4.9E-2
Lead	6.2E-1	7.2E-1	1.9E-1	5.2E-1	4.4E-1	1.4E+1	1.7E+0	7.9E+0	1.0E+1	2.1E+0	4.0E+0	1.9E+0	2.9E+0	4.8E+0	7.7E-1	7.5E+0	2.6E-1	7.9E+0
Manganese	1.2E-1	6.1E-2	4.3E-2	7.0E-2	9.6E-2	3.5E-1	1.1E-1	5.8E-1	5.2E-1	1.1E-1	2.8E-1	6.7E-2	9.9E-2	2.5E+0	-	5.7E-1	5.0E-2	5.8E-1
Mercury	8.4E-3	6.0E-3	4.8E-3	1.2E-2	6.3E-3	1.4E-2	1.3E-2	1.6E-2	1.4E-2	-	6.5E-2	-	1.5E-2	2.8E-2	3.0E-2	1.7E-2	1.3E-4	1.6E-2
Molybdenum	1.5E-1	6.1E-2	7.2E-2	4.0E-2	4.6E-2	1.4E+0	1.5E+0	5.7E-1	6.7E+0	2.9E+0	1.6E+0	1.0E+1	3.2E-1	7.4E-1	1.1E-1	1.0E+0	6.8E-2	5.7E-1
Nickel	1.3E-2	1.0E-2	1.2E-2	1.5E-1	2.7E-2	3.6E-2	3.8E-2	-	-	3.1E-2	-	4.2E-2	7.1E-3	1.6E-2	-	-	2.0E-3	-
Selenium	4.9E-1	1.5E-1	8.4E-2	2.8E-1	8.4E-2	1.4E+0	1.3E-1	8.2E-1	6.2E+0	8.2E+0	6.9E-1	1.0E+0	2.2E-1	5.5E-1	1.4E-1	1.0E+0	3.5E-1	8.2E-1
Silver	1.1E-4	2.6E-5	3.1E-5	5.2E-5	2.6E-5	-	4.4E-5	1.6E-4	8.7E-5	2.7E-4	4.4E-4	3.1E-4	3.4E-5	6.5E-5	2.2E-4	-	7.3E-4	1.6E-4
Strontium	8.4E-1	1.4E+0	1.9E-1	1.1E+0	1.7E-1	2.4E+1	1.3E+0	2.4E+1	2.6E+1	1.4E+1	7.7E+0	9.3E+0	7.6E+0	7.5E+0	1.2E+0	1.7E+1	3.9E+0	2.4E+1
Thallium	3.0E-1	2.0E-1	1.8E-1	9.1E-1	1.9E-1	6.5E-1	1.6E-1	-	4.7E-2	4.7E-1	3.0E-1	9.3E-3	9.3E-3	4.7E-2	1.4E-1	-	4.2E+0	-
Vanadium	7.2E-1	9.6E-1	9.7E-1	1.7E+0	2.2E+0	2.1E+0	1.2E+0	-	3.7E+0	1.8E+0	-	1.5E+0	-	9.5E-1	-	9.6E-1	3.8E-1	-
Yttrium	1.9E-1	9.3E-2	5.4E-2	2.6E-1	9.1E-2	8.1E-1	8.8E-2	4.9E-1	5.3E-1	2.0E+1	5.8E-1	2.5E-1	-	6.8E-1	7.7E-2	5.2E-1	-	4.9E-1
Zinc	4.0E-2	3.1E-2	2.2E-2	4.3E-2	3.6E-2	4.7E-2	-	5.2E-2	-	9.8E-2	-	-	-	-	-	4.7E-2	4.7E-2	5.2E-2
Total Metals[9]	9.8E+0	1.0E+1	3.2E+0	1.7E+1	5.7E+0	6.1E+1	1.2E+1	5.4E+1	6.8E+1	6.0E+1	2.1E+1	4.7E+1	2.7E+1	3.0E+1	9.8E+0	4.7E+1	1.0E+1	5.4E+1
Lanthanide Metals																		
Cerium	3.0E+0	2.1E+0	2.8E-1	7.1E-1	2.6E-1	1.4E+1	5.3E+0	1.7E+1	1.5E+1	2.7E+2	6.8E+0	1.2E+1	3.7E+0	-	1.2E+0	1.9E+1	-	1.7E+1
Lanthanum	1.4E+0	9.9E-1	1.7E-1	3.6E-1	1.4E-1	1.0E+1	3.5E+0	1.2E+1	1.3E+1	6.5E+2	8.5E+0	6.5E+0	2.8E+0	1.4E+1	8.5E-1	1.4E+1	-	1.2E+1
Neodymium	6.0E-1	3.9E-1	7.1E-2	2.8E-1	7.5E-2	4.2E+0	1.3E+0	4.9E+0	6.6E+0	1.5E+2	2.9E+0	2.4E+0	9.0E-1	3.9E+0	4.3E-1	6.7E+0	-	4.9E+0
Praseodymium	2.0E-1	1.8E-1	2.4E-2	7.3E-2	2.1E-2	1.4E+0	4.4E-1	1.5E+0	2.1E+0	5.3E+1	1.0E+0	9.4E-1	3.2E-1	1.6E+0	1.2E-1	1.7E+0	-	1.5E+0
Samarium	2.0E-1	3.1E-2	5.8E-3	3.6E-2	6.7E-3	3.0E-1	8.6E-2	3.3E-1	3.4E-1	3.0E+1	4.1E-1	1.7E-1	5.9E-2	3.4E-1	2.8E-2	3.5E-1	-	3.3E-1
Total Lanthanides[9]	3.1E+1	3.1E+1	3.1E+1	3.1E+1	3.1E+1	3.1E+1	1.1E+1	3.6E+1	3.8E+1	1.2E+3	2.0E+1	2.3E+1	7.8E+0	2.1E+1	2.7E+0	4.2E+1		3.6E+1
Actinide Metals																		
Thorium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	4.5E-3	3.6E-3	2.3E-3	1.4E-2	1.3E-3	8.7E-2	2.0E-2	5.2E-2	3.5E-2	4.4E-2	2.0E-2	3.2E-2	3.1E-2	2.8E-2	4.4E-3	6.7E-2	-	5.2E-2
Radionuclides																		
Total Radionuclides	7.5E-2	8.9E-2	3.9E-2	2.9E-1	3.9E-2	6.1E-1	P	3.2E-1	1.2E+0	6.9E+0	3.7E-1	2.5E-1	1.9E-1	3.6E-1	P	4.6E-1	NE	3.2E-1
GRAND SUM[9]	4.1E+1	4.1E+1	3.4E+1	4.8E+1	3.7E+1	9.2E+1	2.3E+1	9.0E+1	1.1E+2	1.2E+3	4.2E+1	7.0E+1	3.6E+1	5.1E+1	1.3E+1	9.0E+1	1.0E+1	9.0E+1

Site presence index for desert kangaroo rat at all AOCs = 1

1 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either younger alluvium (YA), bedrock (BD), or older alluvium (OA).
2 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or shonkenite (SK).
3 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or older alluvium (OA).
4 - HQ from exposure to background soil is the HQ from bedrock (BD).
5 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX), bedrock (BD), or older alluvium (OA).
6 - HQ from exposure to background soil is the HQ from older alluvium (OA).
7 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX) or older alluvium (OA).
8 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or younger alluvium (YA).
9 - Summed HQs are provided only to facilitate spatial comparisons—summed HQ values are not intended to demonstrate the magnitude of total risk.

\- = Not a COPC
NA = Not available
NE = Not evaluated
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-24
Risk Estimates for the Desert Shrew at Mine & Mill Site Areas of Concern

	HQs Due to Ingestion of Food, Soils, Fugitive Dust, and Surface Water																	
	Background																	
COPEC	Bedrock	Older Alluvium	Younger Alluvium	Shonkenite	Mixed	Overburden Stockpile[1]	North Tailings Pond (P-16)[2]	Windblown Tailings[3]	Seepage Collection Pond (P-23)[4]	Lanthanide Storage Ponds (P-25 and P-28)[3]	Sewage Treatment Pond (P-19)[5]	Administration Pond[6]	17 Spring[3]	Jack Meyer's Pond Spring[6]	Wheaton Wash / Roseberry Spring[7]	Pit Lake[2]	Future Onsite Evaporation Ponds[8]	East Tailings Pond
Metals																		
Antimony	4.5E-1	9.7E-2	3.6E-1	1.6E-1	0.0E+0	1.3E+1	6.1E-1	6.1E+0	2.6E+0	1.2E+1	1.3E+0	1.7E+0	1.5E+0	6.8E+0	6.9E-1	6.6E+0	4.5E-1	6.1E+0
Arsenic	3.1E-1	1.8E-1	1.7E-1	1.3E-1	3.5E-1	-	5.2E-1	-	2.4E-1	6.6E-1	-	2.2E-1	1.7E-1	3.4E-1	-	-	7.3E-2	-
Barium	3.5E+0	3.6E+0	6.6E-1	6.2E+0	1.1E+0	8.5E+0	3.1E+0	1.1E+1	8.4E+0	5.4E+0	3.5E+0	1.3E+1	9.5E+0	6.7E+0	4.3E+0	1.1E+1	4.2E-1	1.1E+1
Beryllium	5.6E-2	2.3E-2	1.9E-2	2.5E-1	3.3E-2	3.7E-1	6.1E-2	5.4E-2	-	7.3E-2	4.4E-2	5.8E-2	2.5E-2	5.4E-2	2.6E-2	1.3E-1	1.5E-2	5.4E-2
Cadmium	1.7E-1	1.9E-1	1.0E-1	8.2E-2	9.9E-2	2.2E-1	2.3E-1	-	2.2E-1	3.6E-1	3.8E-1	3.4E-1	7.0E-2	2.3E-1	2.3E-1	-	5.3E-3	-
Chromium	8.8E-1	9.0E-1	7.8E-1	1.4E+1	1.4E+0	3.9E+0	1.6E+0	-	1.8E+0	1.4E+0	1.9E+0	4.6E+0	6.2E-1	1.1E+0	-	-	1.2E-2	-
Cobalt	2.7E-1	1.7E-1	1.4E-1	5.1E-1	4.8E-1	4.4E-1	3.1E-1	-	-	6.0E-1	-	-	-	-	-	-	1.6E-2	-
Copper	1.2E-1	1.1E-1	1.0E-1	1.6E-1	1.4E-1	1.3E-1	1.4E-1	1.2E-1	1.3E-1	1.5E-1	1.3E-1	1.3E-1	9.5E-2	1.3E-1	-	1.3E-1	2.1E-3	1.2E-1
Lead	4.3E+0	5.0E+0	1.2E+0	3.6E+0	3.0E+0	8.4E+1	5.2E+0	4.9E+1	6.4E+1	1.4E+1	2.6E+1	1.3E+1	1.9E+1	3.1E+1	5.4E+0	4.7E+1	4.4E-1	4.9E+1
Manganese	1.5E-1	8.4E-2	6.3E-2	9.5E-2	1.3E-1	3.9E-1	1.7E-1	6.3E-1	5.8E-1	1.4E-1	3.2E-1	9.1E-2	1.3E-1	2.4E+0	-	6.1E-1	8.3E-2	6.3E-1
Mercury	6.4E-2	5.2E-2	4.6E-2	8.0E-2	5.4E-2	8.9E-2	8.5E-2	9.6E-2	8.6E-2	-	2.3E-1	-	9.2E-2	1.3E-1	1.4E-1	9.7E-2	2.6E-4	9.6E-2
Molybdenum	7.0E-1	2.8E-1	3.4E-1	1.9E-1	2.2E-1	6.4E+0	4.6E+0	3.0E+0	2.9E+1	1.4E+1	7.5E+0	4.8E+1	1.5E+0	3.4E+0	5.3E-1	4.8E+0	1.1E-1	3.0E+0
Nickel	1.5E-1	1.2E-1	1.4E-1	2.2E+0	3.6E-1	4.9E-1	4.8E-1	-	-	4.0E-1	-	5.7E-1	7.5E-2	1.9E-1	-	-	3.4E-3	-
Selenium	1.4E+0	6.2E-1	4.1E-1	9.5E-1	4.1E-1	2.9E+0	5.5E-1	2.0E+0	8.2E+0	1.0E+1	1.7E+0	2.3E+0	7.9E-1	1.5E+0	5.7E-1	2.3E+0	7.5E-1	2.0E+0
Silver	3.6E-3	8.6E-4	1.0E-3	1.7E-3	8.5E-4	-	1.2E-3	5.3E-3	2.3E-3	2.8E-3	1.4E-2	1.0E-2	1.0E-3	1.5E-3	4.7E-3	-	1.2E-3	5.3E-3
Strontium	8.5E-2	1.4E-1	1.9E-2	1.2E-1	1.8E-2	2.4E+0	3.2E-1	2.5E+0	2.7E+0	2.5E+0	7.8E-1	9.4E-1	7.8E-1	9.4E-1	1.5E-1	1.9E+0	6.6E+0	2.5E+0
Thallium	3.7E+0	2.4E+0	2.1E+0	1.1E+1	2.3E+0	7.9E+0	1.7E+0	-	5.1E-2	5.1E-1	3.7E+0	1.0E-2	1.0E-2	5.1E-2	1.7E+0	-	4.5E+0	-
Vanadium	1.6E+0	2.1E+0	2.1E+0	3.6E+0	4.8E+0	4.5E+0	2.5E+0	-	7.7E+0	3.9E+0	-	3.4E+0	-	2.1E+0	-	2.1E+0	6.4E-1	-
Yttrium	3.2E+0	1.5E+0	8.9E-1	4.2E+0	1.5E+0	1.3E+1	1.0E+0	8.1E+0	8.7E+0	3.2E+2	9.6E+0	4.1E+0	-	1.1E+1	1.3E+0	8.6E+0	-	8.1E+0
Zinc	8.6E-2	7.4E-2	6.0E-2	8.9E-2	8.0E-2	9.3E-2	-	9.9E-2	-	1.4E-1	-	-	-	-	-	9.3E-2	2.2E-2	9.9E-2
Total Metals[9]	2.1E+1	1.8E+1	9.8E+0	4.7E+1	1.6E+1	1.5E+2	2.3E+1	8.3E+1	1.3E+2	3.8E+2	5.7E+1	9.2E+1	3.5E+1	6.8E+1	1.5E+1	8.5E+1	1.4E+1	8.3E+1
Lanthanide Metals																		
Cerium	3.0E+2	2.1E+2	2.8E+1	7.1E+1	2.7E+1	1.5E+3	4.5E+1	1.7E+3	1.5E+3	2.4E+4	6.9E+2	1.2E+3	3.6E+2	-	1.2E+2	1.9E+3	-	1.7E+3
Dysprosium	1.4E+0	5.2E-1	2.2E-1	9.4E-1	3.4E-1	4.6E+0	2.6E-1	4.0E+0	1.6E+1	1.8E+2	6.5E+0	2.2E+0	9.0E-1	5.5E+0	4.9E-1	4.5E+0	-	4.0E+0
Erbium	4.7E-1	3.0E-1	1.0E-1	3.5E-1	1.7E-1	2.3E+0	1.2E-1	2.5E+0	6.8E+0	6.1E+1	2.0E+0	1.3E+0	5.2E-1	3.3E+0	2.6E-1	2.6E+0	-	2.5E+0
Europium	2.6E+0	5.2E-1	9.1E-2	9.1E-1	1.1E-1	5.2E+0	2.2E-1	4.9E+0	4.7E+0	4.5E+1	6.7E+0	3.0E+0	1.1E+0	5.8E+0	5.0E-1	5.9E+0	-	4.9E+0
Gadolinium	1.3E+1	5.9E+0	7.3E-1	3.6E+0	8.3E-1	4.1E+1	1.3E+0	5.2E+1	4.7E+1	7.9E+2	3.8E+1	2.6E+1	7.9E+0	4.8E+1	3.7E+0	5.1E+1	-	5.2E+1
Holmium	1.3E-1	5.4E-2	3.0E-2	1.1E-1	5.3E-2	4.0E-1	3.2E-2	2.4E-1	1.9E+0	1.0E+1	5.3E-1	1.6E-1	8.0E-2	4.6E-1	-	2.9E-1	-	2.4E-1
Lanthanum	1.4E+2	1.0E+2	1.8E+1	3.7E+1	1.4E+1	1.0E+3	2.8E+1	1.2E+3	1.3E+3	2.8E+4	8.5E+2	6.5E+2	2.7E+2	1.4E+3	8.6E+1	1.4E+3	-	1.2E+3
Lutetium	2.4E-2	1.8E-2	9.4E-3	2.0E-2	1.5E-2	6.8E-2	9.3E-3	8.0E-2	8.7E-2	6.0E-1	5.6E-2	4.0E-2	2.2E-2	1.4E-1	-	7.4E-2	-	8.0E-2
Neodymium	6.1E+1	4.0E+1	7.1E+0	2.8E+1	7.5E+0	4.2E+2	1.3E+1	4.9E+2	6.6E+2	1.2E+4	2.9E+2	2.4E+2	8.9E+1	4.0E+2	4.3E+1	6.7E+2	-	4.9E+2
Praseodymium	2.0E+1	1.8E+1	2.4E+0	7.4E+0	2.1E+0	1.4E+2	3.7E+0	1.5E+2	2.1E+2	3.9E+3	1.0E+2	9.5E+1	3.2E+1	1.6E+2	1.2E+1	1.7E+2	-	1.5E+2
Samarium	2.0E+1	3.1E+0	5.9E-1	3.7E+0	6.8E-1	3.1E+1	1.2E+0	3.3E+1	3.4E+1	2.7E+3	4.2E+1	1.7E+1	5.8E+0	3.4E+1	2.9E+0	3.5E+1	-	3.3E+1
Terbium	5.5E-1	2.4E-1	4.5E-2	2.8E-1	6.4E-2	1.8E+0	7.8E-2	2.1E+0	3.5E+0	6.2E+1	7.0E+0	1.2E+0	4.6E-1	2.7E+0	1.8E-1	2.2E+0	-	2.1E+0
Thulium	1.7E-2	1.5E-2	1.0E-2	2.6E-2	1.7E-2	7.1E-2	9.9E-3	4.6E-2	6.4E-2	9.0E-1	3.4E-2	2.1E-2	1.7E-2	1.2E-1	-	5.2E-2	-	4.6E-2
Ytterbium	1.7E-1	9.7E-2	6.4E-2	1.5E-1	1.1E-1	4.8E-1	6.0E-2	4.4E-1	4.3E-1	8.6E+0	2.8E-1	1.7E-1	1.2E-1	7.9E-1	-	4.3E-1	-	4.4E-1
Total Lanthanides[9]	5.7E+2	3.8E+2	5.7E+1	1.5E+2	5.3E+1	3.1E+3	9.4E+1	3.6E+3	3.8E+3	7.2E+4	2.0E+3	2.3E+3	7.7E+2	2.1E+3	2.7E+2	4.2E+3		3.6E+3
Actinide Metals																		
Thorium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium	8.7E-3	7.0E-3	4.4E-3	2.7E-2	2.5E-3	1.7E-1	3.6E-2	1.0E-1	6.9E-2	8.4E-2	3.8E-2	6.3E-2	6.0E-2	5.4E-2	8.3E-3	1.3E-1	-	1.0E-1
Radionuclides																		
Total Radionuclides	7.3E-1	8.6E-1	3.8E-1	2.8E+0	4.7E-1	6.0E+0	P	3.2E+0	1.2E+1	6.6E+1	3.6E+0	2.4E+0	1.8E+0	3.5E+0	P	3.8E+0	P	3.2E+0
GRAND SUM[9]	5.9E+2	4.0E+2	6.7E+1	2.0E+2	7.0E+1	3.3E+3	1.2E+2	3.7E+3	3.9E+3	7.3E+4	2.1E+3	2.4E+3	8.1E+2	2.1E+3	2.8E+2	4.3E+3	1.4E+1	3.7E+3

Site presence index for desert shrew at all AOCs = 1

1 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either younger alluvium (YA), bedrock (BD), or older alluvium (OA).
2 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or shonkenite (SK).
3 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or older alluvium (OA).
4 - HQ from exposure to background soil is the HQ from bedrock (BD).
5 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX), bedrock (BD), or older alluvium (OA).
6 - HQ from exposure to background soil is the HQ from older alluvium (OA).
7 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX) or older alluvium (OA).
8 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either bedrock (BD) or younger alluvium (YA).
9 - Summed HQs are provided only to facilitate spatial comparisons—summed HQ values are not intended to demonstrate the magnitude of total risk.

\- = Not a COPC
NA = Not available
NE = Not evaluated
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-25
Risk Estimates for the Bighorn Sheep at Mine & Mill Site Areas of Concern

COPEC	HQs Due to Ingestion of Food, Soils, and Surface Water			
	Background[1]		Baseline Scenario[2]	Future Expansion Scenario[3]
	baseline	future	Wide Ranging AOC	Wide Ranging AOC
Metals				
Antimony	6.1E-4	1.0E-3	2.2E-2	3.5E-2
Arsenic	1.1E-2	1.8E-2	2.7E-2	4.3E-2
Barium	1.8E+0	3.0E+0	3.2E+0	5.2E+0
Beryllium	2.8E-3	4.7E-3	4.0E-3	7.5E-3
Cadmium	4.4E-3	7.4E-3	6.4E-3	1.0E-2
Chromium	3.8E-2	6.3E-2	1.2E-2	2.0E-2
Cobalt	3.3E-3	5.5E-3	3.8E-3	6.1E-3
Copper	4.0E-3	6.7E-3	3.7E-3	6.0E-3
Lead	2.9E-2	4.8E-2	4.8E-1	8.0E-1
Manganese	5.4E-3	9.1E-3	5.9E-2	5.7E-2
Mercury	6.3E-4	1.1E-3	4.6E-3	3.5E-3
Molybdenum	8.8E-3	1.5E-2	5.9E-1	4.7E-1
Nickel	4.6E-3	7.6E-3	1.3E-3	2.7E-3
Selenium	2.1E-2	3.4E-2	3.0E-1	2.2E-1
Silver	2.8E-6	4.7E-6	1.0E-5	1.4E-5
Strontium	9.8E-2	1.6E-1	1.9E+0	3.1E+0
Thallium	4.1E-2	6.8E-2	3.4E-2	5.6E-2
Vanadium	4.5E-2	7.6E-2	1.0E-1	1.7E-1
Yttrium	6.7E-3	1.1E-2	3.0E-1	1.5E-1
Zinc	2.8E-2	4.7E-2	4.1E-2	5.9E-2
Total Metals[4]	2.1E+0	3.6E+0	7.1E+0	1.0E+1
Lanthanide Metals				
Cerium	1.6E-1	2.7E-1	1.6E+1	9.4E+0
Lanthanum	7.7E-2	1.3E-1	5.2E+1	6.6E+1
Neodymium	3.3E-2	5.5E-2	9.1E+0	7.9E+0
Praseodymium	1.1E-2	1.8E-2	3.5E+0	3.0E+0
Samarium	1.1E-2	1.8E-2	1.5E+0	7.2E-1
Total Lanthanides[4]	3.1E-1	5.1E-1	8.2E+1	8.8E+1
Actinide Metals				
Thorium	NR	NR	NR	NR
Uranium	3.1E-4	5.2E-4	2.7E-3	4.7E-3
Radionuclides				
Total Radionuclides			3.4E-2	2.8E-2
GRAND SUM[4]	2.4E+0	4.1E+0	8.9E+1	9.8E+1

1 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX), bedrock (BD), older alluvium (OA), or shonkenite (SK).
2 - Site presence index for bighorn sheep in baseline scenario = 0.12 for metals.
3 - Site presence index for bighorn sheep in future expansion scenario = 0.20 for metals.
4 - Summed HQs are provided only to facilitate spatial comparisons —summed HQ values are not intended to demonstrate the magnitude of total risk.

\- = Not a COPC
NA = Not available
NE = Not evaluated
NR = No RTV
P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-26
Risk Estimates for the Coyote at Mine & Mill Site Areas of Concern

COPEC	HQs Due to Ingestion of Food, Soils, and Surface Water			
	Background[1]		Baseline Scenario[2]	Future Expansion Scenario[3]
	baseline	future	Wide Ranging AOC	Wide Ranging AOC
Metals				
Antimony	2.9E-4	4.8E-4	1.0E-2	1.6E-2
Arsenic	1.4E-3	2.4E-3	7.4E-3	1.1E-2
Barium	2.5E-1	4.2E-1	6.7E-1	1.1E+0
Beryllium	1.3E-3	2.2E-3	1.9E-3	3.6E-3
Cadmium	3.9E-3	6.6E-3	7.3E-3	1.2E-2
Chromium	1.1E-2	1.8E-2	9.6E-3	1.6E-2
Cobalt	2.4E-3	4.0E-3	3.0E-3	4.8E-3
Copper	3.2E-3	5.4E-3	3.5E-3	5.7E-3
Lead	4.7E-2	7.8E-2	4.4E-1	7.3E-1
Manganese	8.0E-4	1.3E-3	9.7E-3	1.0E-2
Mercury	2.4E-5	4.0E-5	1.1E-3	5.1E-4
Molybdenum	4.7E-4	7.9E-4	6.4E-2	8.0E-2
Nickel	2.0E-3	3.3E-3	1.2E-3	2.4E-3
Selenium	1.1E-2	1.8E-2	3.5E-2	3.9E-2
Silver	1.2E-6	2.0E-6	4.3E-6	5.7E-6
Strontium	5.7E-4	9.4E-4	3.8E-2	6.4E-2
Thallium	4.8E-2	8.0E-2	7.5E-2	1.3E-1
Vanadium	2.6E-2	4.4E-2	5.1E-2	8.2E-2
Yttrium	2.7E-3	4.6E-3	1.2E-1	6.3E-2
Zinc	2.9E-1	4.8E-1	3.3E-1	5.2E-1
Total Metals [4]	7.1E-1	1.2E+0	1.9E+0	2.9E+0
Lanthanide Metals				
Cerium	1.3E-2	2.1E-2	2.1E+0	2.2E+0
Lanthanum	6.0E-3	1.0E-2	1.7E+1	2.6E+1
Neodymium	2.5E-3	4.2E-3	2.0E+0	2.7E+0
Praseodymium	8.5E-4	1.4E-3	7.7E-1	1.1E+0
Samarium	8.4E-4	1.4E-3	2.2E-1	2.3E-1
Total Lanthanides [4]	2.4E-2	4.0E-2	2.2E+1	3.2E+1
Actinide Metals				
Thorium	NR	NR	NR	NR
Uranium	1.6E-4	2.6E-4	1.3E-3	2.2E-3
Radionuclides				
Total Radionuclides	NE	NE	NE	NE
GRAND SUM[4]	7.3E-1	1.2E+0	2.4E+1	3.5E+1

Data presented for coyote ingesting insectivorous prey

1 - HQ from exposure to background soil is the maximum HQ, on a chemical-per-chemical basis, from either mixed (MX), bedrock (BD), older alluvium (OA), or shonkenite (SK).

2 - Site presence index for coyote in baseline scenario = 0.05

3 - Site presence index for coyote in future expansion scenario = 0.08

4 - Summed HQs are provided only to facilitate spatial comparisons —summed HQ values are not intended to demonstrate the magnitude of total risk.

\- = Not a COPC

NA = Not available

NE = Not evaluated

NR = No RTV

P = Receptor passed the initial screen of the DOE BCG graded approach (= negligible risk); therefore, site was not evaluated further.

Color-coded relative risks were calculated according to the decision tree provided in Section 3.3, Hazard Quotients.

>25
21—25
16—20
11—15
6—10
1—5
<1

Table 3-27
Maximum Concentrations of Strontium in Surface Water and Shallow Groundwater Relative to Ore Body Fault and Mining Activities

Location	**Relation to Ore or Mine Activities** Relative to ore body fault	Relative to mining activities	**Well**	**Rock Type**[a]	**Maximum Strontium Concentrations**[b] (mg/L)
Offsite—north of facility	Upgradient	Upgradient	93-1MW	Gneiss	2.7
Northwest of pit mine	Downgradient	Upgradient of open pit mine; Crossgradient from P-16	93-2RMW	Braided stream	0.51
Northwest of pit mine	Downgradient	Upgradient of open pit mine; Crossgradient from P-16	93-4RMW	Braided stream	1.2
N. Tailings Pond	Downgradient	P-16	—	—	187[c]
Jack Meyers' Pond Spring	Downgradient	Downgradient of P-16 (~1000m)	—	—	180[c]
Wheaton Wash	—	Downgradient of P-16 (~1900m)	SRK-20U	Braided stream	120

a - based on geologic map [Figure 4.1] provided in *A Groundwater Hydrology and Modeling Investigation of Molycorp Mountain Pass Mine and Mill Site, Mountain Pass, CA. (Geomega 2000)*

b - from groundwater database provided by Molycorp and measured concentrations in surface water

c - from surface water samples collected by Tetra Tech (June 1999)

Table 3-28
Relative Dermal and Ingestion Risks to the Desert Kangaroo Rat at the Windblown Tailings AOC

			Ingestion[b]			Dermal Contact[c]						
Chemical	0-0.5 ft Soil EPC (mg/kg)[a]	Kangaroo Rat Body Weight (kg)	Total Ingestion Dose (mg/kg/day)	RTV (mg/kg/day)	HQ	Percent Body in Contact w/ Soil	Surface Area[d] (cm^2)	Dermal Adherence Factor[e] (mg/cm^2)	External Dermal Exposure (mg/kg)[d,e]	RTV (mg/kg)[f]	HQ	**Dermal HQ as Percent of Total HQ**
Lead	1.95E+3	1.04E-1	8.28E+0	1.05E+0	7.9E+0	100%	87.6	1.00E+0	1.64E+0	9.91E+0	1.7E-1	**2.16%**

Definitions:

- EPC - Exposure point concentration.
- HQ - Hazard quotient.
- mg/kg - Milligrams per kilogram.
- RME - Reasonable maximum exposure.
- RTV - Reference toxicity value.

Notes:

a - Lead RME concentration in soil at the Windblown Tailings.
b - From Table 3-23.
c - The example dermal risk calculation is described in Section 3.4.1.
d - The dermal surface area (87.6 cm^2) was estimated with with the allometric formula for the mammalian skin surface area-body weight relationship (U.S. EPA 1993, Wildlife Exposure Factors Handbook)
e - A soil-skin adherence factor of 1 mg/cm^2 was assumed (U.S. EPA 1992, Dermal Exposure Assessment)
f - NOAEL-equivalent toxicity benchmark developed from an acute LOAEL for a rabbit (Lewis 1992). The desert kangaroo rat-specific RTV was calculated from the benchmark using a mammalian body weight scaling factor of 0.06 (Sample and Arenal 1999). The test species body weight was assumed to be 2 kg (Lewis 1984).

Table 3-29a
Comparison of Recent Toxicity Values to RTVs for Mountain Pass Mine: Water Quality Criteria for California

Chemical	Aquat. Biota RTV (ug/L)	CA Toxics Rule (ug/L)	RTV/WQC
Arsenic	150	150	1.0
Cadmium[h]	2.2	2.2	1.0
Chromium[h]	74	180	0.4
Copper[h]	9	9.0	1.0
Lead[h]	3	2.5	1.0
Mercury	0.77	[reserved]	—
Nickel[h]	52	52	1.0
Selenium	5	5.0	
Zinc[h]	120	120	1.0

Notes:

Values displayed in table correspond to a water hardness of 100 mg/L CaCO3.

h - hardness-dependent

WQC - Water quality criteria provided in CA Toxics Rule (Federal Register 2000)

Aquat. Biota RTV - Reference toxicity value used to evaluate potential risks to aquatic biota

Table 3-29b
Comparison of Recent Toxicity Values to RTVs for Mountain Pass Mine: Sediment Quality Guidelines for Freshwater Ecosystems

Chemical	Sediment RTV (mg/kg)	TEC (mg/kg)	RTV/TEC
Arsenic	8	9.8	0.8
Cadmium	1.2	0.99	1.2
Chromium	81	43	1.9
Copper	34	32	1.1
Lead	47	36	1.3
Mercury	0.15	0.18	0.8
Nickel	21	23	0.9
Zinc	150	121	1.2

Notes:

TEC - Consensus-based threshold effect concentration (MacDonald *et al.* 2000)

Sediment RTV - Reference toxicity value used to evaluate potential risks to sediment-associated biota

4.0 CONCLUSION

This human health and ecological risk assessment organized and evaluated an extensive amount of data for the Mountain Pass mine and mill site to predict chemical and radiological exposures of humans, plants, and animals. The resulting risk estimates provide an organized basis for making decisions as part of the EIR.

4.1 POTENTIAL HUMAN HEALTH IMPACTS

The human health risk assessment (HHRA) evaluated the potential for adverse health effects to occur as a result of exposure to chemical and radiological releases under baseline, proposed future expansion, and reference conditions for the Mountain Pass mine and mill facility. Risks were estimated for three groups of receptors:

- Day visitors: typified as employees of companies transporting materials to and from the mine and mill site.
- Schoolchildren at Mountain Pass Elementary School; and
- Offsite residents: Mountain Pass residents (CHP and Caltrans employees and families) consisting of three age groups (young children, school-age children, and older children or adults).

Risks estimated for baseline and future conditions are comparable for all three groups of receptors, although risk estimates for future conditions are slightly higher than those estimated for baseline conditions. The risks estimated for each group of receptors are presented below and in Figures 2-3 to 2-9:

The following conclusions were reached regarding risks for the day visitor and school child:

- Cancer risk estimates are substantially less than the generally acceptable range of 1×10^{-6} to 1×10^{-4}.
- Noncancer health effects are substantially less than a hazard criterion of 1.

Thus, the risks estimated for the day visitor and school child are negligible.

The conclusions regarding cancer risks for the offsite residents differ from those for the noncancer risks. The cancer risk estimates are within the generally acceptable range of 1 x 10^{-6} to 1 x 10^{-4}, whereas the noncancer risks are of potential concern. The inhalation exposure pathway is the primary concern for noncancer health effects for all three age groups:

- Noncancer health effects to the respiratory system are of concern for all three age groups (young child, school-age child, and adult).
- Inhalation of lanthanide metals is the primary route of exposure for the noncancer health concerns determined for offsite residents. The respiratory system effects of the lanthanide metals involves cell changes in lung tissue (TERA 2001).
- None of the HIs exceed 1 for the other COPCs that contribute to noncancer effects on the respiratory system.

Thus, inhalation of lanthanide metals is the primary source of noncancer health concerns for offsite residents for both baseline and future conditions.

The predicted noncancer health risks necessitate further consideration. First, the predicted health risks are based on exposure concentrations estimated using air dispersion modeling. However, recent air monitoring conducted in the vicinity of the mine and mill site indicates that the air modeling results may have overestimated exposures to airborne lanthanide metals. Second, the health effects of lanthanide metals are based on a relatively small set of experimental studies. As a result, there is a considerable level of uncertainty associated with these risk estimates.

Since the air dispersion modeling results do not provide the information necessary to identify the sources of the lanthanide metals, it cannot be determined whether the same emission sources contribute to elevated lanthanide metal concentrations under the baseline and future exposure scenarios. These sources should be identified in order to determine whether the health risks can be mitigated.

The potential risks to offsite residents should be addressed by adopting a long-term monitoring program. The monitoring program should include measurements of wind speed and direction at the primary receptor locations as well as the concentrations of airborne constituents, such as the lanthanide metals. Also, additional experimental evidence is necessary to fully characterize the potential health effects of the lanthanide metals.

4.2 POTENTIAL ECOLOGICAL IMPACTS

The ecological risk assessment (ERA) evaluated the likelihood of adverse ecological effects that may occur as a result of exposure to metals, lanthanide metals, and radionuclides. Adverse effects (risks) examined by this ERA are impacts related to sustaining existing desert communities and resident wildlife populations. Potential ecological risks were evaluated for the following biological resources observed at the mine and mill site:

- Aquatic and sediment-associated invertebrate communities
- Plant communities
- Soil invertebrate communities
- Desert tortoise and other reptile populations
- Waterfowl populations
- Herbivorous, insectivorous, and carnivorous bird populations
- Herbivorous, insectivorous, and carnivorous mammal populations

Fish and amphibians were not evaluated because (b) they have not been observed at mine and mill site AOCs, (b) intermittent ponds and springs are not connected to freshwater systems that support fish or amphibian populations, (c) intermittent surface waterbodies are not present long enough to sustain fish populations, and (d) existing information suggests that amphibians play a relatively minor ecological role in desert habitats (Heatwole 1982).

Ecological risks were evaluated for twelve onsite AOCs and one nearby offsite AOC. Most of these AOCs are located at or near onsite areas that were developed for industrial use, are highly disturbed, and are characterized by human and/or vehicular activity. Based on visual observations, habitats immediately surrounding these AOCs appeared to be relatively undisturbed by site-related activities and are likely to more attractive to wildlife receptors.

Under the baseline scenario, the greatest potential for adverse impacts exists for:

- Aquatic and sediment-associated invertebrate communities at onsite springs in drainages directly below the North Tailings Pond
- Desert plant communities at the Seepage Collection Pond, Windblown Tailings, and Overburden Stockpile
- Soil invertebrate communities at the Lanthanide Storage Ponds
- Mammal populations at the Lanthanide Storage Pond

A single desert tortoise, a federally threatened species, has been observed outside the western boundary of the site. Although no desert tortoises have been observed in areas examined in this ERA, risks to the desert tortoise were evaluated to ensure a conservative assessment. Risk estimates for the desert tortoise were among the lowest calculated for the mine and mill site—exposures at the Lanthanide Storage Ponds and Overburden Stockpile posed the greatest risk to this species of regulatory concern.

Spatial Pattern. Baseline ecological risks were greatest at the Seepage Collection Pond, Lanthanide Storage Ponds, Overburden Stockpile, and Windblown Tailings. Baseline ecological risks tend to diminish with distance from these areas. For the most part, baseline ecological risks are negligible at Wheaton Wash/Roseberry Spring, a nearby offsite area.

Minimally disturbed desert scrub habitat was often observed within 100 feet of these AOCs. Results from the North Tailings Pond suggest that minimally disturbed areas surrounding developed impoundments pose a negligible risk to plant, invertebrate, and wildlife receptors. Nonetheless, effective "housekeeping" at these developed areas and controls to reduce contact (*e.g.*, fences) are likely to significantly reduce the potential for adverse ecological impacts at the mine and mill site.

Because baseline conditions were often used to estimate future risks, the magnitude and spatial pattern of future risks are similar to the baseline scenario, with the following exceptions:

- Closure and reclamation of North Tailings Pond
- Construction of a lined East Tailings Pond to handle future tailings processing
- Loss of several onsite springs due to elimination of seepage from Tailings Pond
- Addition of onsite evaporation pond system
- Formation of Pit Lake at the open pit mine

Under the future expansion scenario, the Seepage Collection Pond, Lanthanide Storage Ponds, Overburden Stockpile, future East Tailings Pond, and future Pit Lake will pose potential risks to desert plant communities, invertebrate communities, and/or wildlife populations, unless future reclamation efforts are performed. The future onsite evaporation ponds are predicted to pose a negligible risk to wildlife populations.

Under the proposed plan, the North Tailings Pond will be closed and reclaimed—a lined East Tailings Pond will be established to handle future tailings processing. Thus, seepage of tailings pond water will be eliminated. The elimination of tailings pond seepage will (a) result in the loss of several attractive onsite springs and (b) significantly reduce metal, lanthanide metal, and radionuclide exposures to aquatic and sediment-associated invertebrate communities in nearby, offsite springs (*e.g.,* Roseberry Spring). However, if seepage is not eliminated, risk analyses suggest that aquatic and sediment-associated invertebrates in downgradient springs may be adversely impacted. In addition, risk analyses indicate that windblown tailings at the East Tailings Pond will pose a potential risk to desert plants, soil invertebrates, and wildlife, unless control measures are effectively applied to prevent the offsite transport of tailings.

Considerations for the EIR. Preliminary analyses for mammals indicate that restricting access to the Lanthanide Storage Ponds and Tailings Pond (both current and future) would significantly reduce wildlife exposure to lanthanide metals at the mine and mill site. Given the lack of lanthanide toxicity data for many biological resources, restricting access may be considered in the EIR as an initial cost-effective means to minimize potential risks.

Judicious monitoring at future expansion areas can provide the information needed to (a) verify predicted risks and (b) identify and proactively minimize or eliminate potential future risks.

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